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Factors Affecting Cotton Production in Louisiana.

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FACTORS AFFECTING COTTON PRODUCTION IN LOUISIANA

A Dissertation

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Factors affecting cotton production in Louisiana have been examined analytically. These factors include: varieties and changes in varieties; climatic and moisture requirements; soil preparation, seeding, fertilization, and cultivation; weed control; disease control; insect control; defoliants, desiccants, and harvesting; handling and ginning; quality, marketing, and utilization; and the role of cotton in the future.

Information was obtained by review of literature on cotton, by participation on the Louisiana Agricultural Extension Task Force Study Committee on Cotton Production Practices, and by personal observation as Extension Cotton Specialist.

A Louisiana producer should select a variety from the group recommended for his area, and plant seed which have been delinted and treated with a fungicide. Seed of the variety grown should have a germination rate above 80 per cent and should be no more than two years from breeder's stock.

Producers should make more extensive use of available weather information and long-range forecasts in planning their work.

Seedbeds should be well pulverized, but firm and smooth, and uniform in height. Clay soils should be broken in the fall or

winter, light textured soils in the spring, except in areas where deep breaking is necessary in the fall to remove hard-pans, or where large amounts of crop residue must be turned under.

Increasing use of heavy equipment and continuous cropping are tending to reduce efficiency from fertilizers. It will be necessary in the future to give more attention to the condition of the soil with regard to organic matter content and aggregation. Fertilizers should be applied according to determined soil needs.

Planting should be done after the soil temperature averages 65° F. at a 2-inch depth for three consecutive days. A plant population of 35,000 to 45,000 plants per acre is most desirable.

Mechanical cultivation is primarily for weed control and should be done only when necessary. Chemical and other methods of weed control should be used more extensively.

Fungicides, cultural practices, and resistant varieties help overcome losses from boll rot, seedling disease and fusarium wilt. Losses from these causes amount to 14 per cent of the crop. Timing, rate, and efficient application are the keys to adequate and economical insect control.

Mechanical harvesting provides the greatest opportunity to cut man-hours per acre and cut cotton production costs. Defoliants are necessary for mechanical harvesting in Louisiana. They should not be applied until 60 per cent of the bolls are open.

Team work between the farmer and the ginner is necessary for maximum ginning efficiency and protection of cotton quality. More accurate measurements for determining the quality of cotton are being developed and used.

Farmers will grow cotton to supply the demands of the consumer, but the efficiency of those involved in cotton production will determine who will continue to grow the crop.

Changes in each of the factors studied greatly affect the others. For example, defoliation is affected by fertilization, weed control, insect control, disease control, and varieties. The grower must approach cotton production from an overall point of view. Efficiency in all practices must be obtained if maximum profits are to be realized.

INTRODUCTION

Three events in the late 1700's contributed greatly to making cotton the major crop of Louisiana. The first event was the introduction of Upland cotton (*Gossypium hirsutum*) which flourished under state soil and climatic conditions and encouraged Louisiana and other southern planters to begin thinking in terms of large-scale cotton production.

The second event occurred in 1771 when Richard Arkwright of Comford, England, completed the first cotton mill with his invention of the water-driven power loom. Hargraves developed his "spinning Jenny" at about the same time.

The third event, and probably the most significant, was the invention of the cotton gin in 1793 by Eli Whitney. Cotton soon was being used so extensively both abroad and in the United States that the growers could hardly keep pace with the demand.

Many crises have occurred in the cotton industry since and pessimistic agriculturists and economists have warned of the approaching downfall of cotton.

At the close of the Civil War many observers predicted that with the freeing of the slaves and because of the prostrate condition of the South, cotton was gone forever. But by 1878 the crop equaled the pre-war record.

When the boll weevil entered Texas from Mexico and reduced Louisiana production from 1,084,000 bales in 1904 to 246,000 bales in 1910, the picture again looked dark for cotton. But this crisis, too, was overcome.

Disappearance of cotton as a major crop was predicted in the 1930's, with the collapse of the tenancy system, and again after World War II, when economists and even some agricultural leaders of Louisiana State University believed that, because of the high cost of labor and the high man-hour requirement of cotton, its days were numbered. However, in the 1950's development of chemical weed control and mechanical harvesting reduced man-hour requirements from approximately 125 hours per acre to 35 hours per acre.

Cotton has faced many serious problems, but eventually all have been overcome, and since the late 1790's cotton has been the major source of farm income in Louisiana.

Today, more people in Louisiana depend on cotton for all or part of their livelihood than on any other farm enterprise. Only once has another farm product grossed as much cash return in a year as has cotton. That was in 1958, when one-third of the cotton acreage allotment was placed in the soil-bank. During that year beef cattle outranked cotton in Louisiana as a source of agricultural income.

In Louisiana and in most other southern states as well, cattle raising and other enterprises are challenging cotton's position as the primary source of farm income.

In the last two decades cotton production has shifted rapidly in Louisiana from the less fertile hill farms to larger, more level and more fertile acreages. Many acres in the upland area which once produced cotton are being devoted to the growth of pine trees and improved pastures. Once-thriving rural communities have become virtual ghost towns and former rural residents have swelled the population of the cities, seeking a new livelihood there.

In general, cotton acreage has been decreasing since the depression years of the early 1930's. Yield per acre, however, has increased rapidly and gross income from cotton has remained about the same.

During these past 30 years Louisiana cotton farmers have faced a number of increasingly critical problems. The price of cotton during that time has ranged from 6 cents per pound to over 40 cents per pound. Government price supports and acreage control programs were developed to stabilize prices. These measures, however, served unintendedly to encourage foreign production and to develop synthetics by pegging the price of domestic cotton. Nevertheless, by utilizing improved practices, growers have made more progress in production since the 1930's than in all previous decades combined.

Cotton yields per acre during the past 30 years in Louisiana have increased from approximately 192 pounds of lint per acre in 1929-35 to 541 pounds of lint per acre in 1959-63. The use of scientific practices, together with changing market demands, has made cotton farming a more complicated and scientific job. In view of the major changes that have taken place in cotton production since 1930, it appears that changing factors in both production and marketing should receive a rather close review.

The purpose of this study, therefore, has been to make an analytical review of: (a) varieties and changes in varieties in the past; (b) climatic and moisture requirements; (c) soil preparation, seeding, fertilization, and cultivation; (d) weed control; (e) disease control; (f) insect control; (g) defoliants, desiccants, and harvesting; (h) handling and ginning; (i) quality, marketing and utilization; and (j) role of cotton in the future.

The results of this study, it is hoped, will be of value not only to research and extension workers but to the entire Louisiana cotton industry, and will facilitate work with producers and planning for the future.

REVIEW OF LITERATURE

Varieties and Changes In Varieties During the Past

The common varieties now being grown in Louisiana have, if traced back to their beginning, a long and somewhat uncertain background. Before discussing them, it is interesting and helpful to take a look at the origin of cultivated cotton.

According to Hutchinson (37) cotton is a cultural and technological rather than a botanical term. It comes from the Arabic word Koton.

Seed and fiber of cotton have many uses. Brown and Ware (14) said the most important is the use of fiber for spinning. The first use of cotton fiber by man antedates written history, possibly by many centuries. The first indications of its use are found in archaeological excavations of the remains of the more ancient civilizations that flourished in dry climates where textiles, buried in graves or covered in city ruins, had not entirely decayed from moisture over the centuries.

Brown and Ware (14) stated that fragments of ancient cotton cloth which were uncovered by excavations at Mohenjo-Daro in the valley of the Indus river in West Pakistan, dated to about 3000 B.C.

According to a 1952 report by Bird and Mahler (10), cotton fabrics were being made in America at about 2500 B.C. The desert conditions of the Peruvian Coast have preserved vast quantities of fabrics dating to at least 2500 B.C. Bird and Mahler stated that the motive promoting the excavation which produced this material stemmed from a theory on the origin of cultivated cotton in the New World.

Hutchinson, Silow, and Stevens (38) proposed the theory mentioned above, which indicated that an Asiatic cotton was introduced into America as a cultivated plant. Botanical evidence indicated that the oldest focal point for the dispersal of cultivated cotton in America lay in northern Peru and Southeastern Equador.

As reported by Bird and Mahler (10), an expedition was organized and a survey made of the oldest community sites. The results were rather surprising, and though they neither proved nor disproved the theory mentioned, they did at least demonstrate that the textile craft of Peru was based primarily on the use of cotton.

More recently, discoveries in a cave near Tehuacan, Mexico now give a new, earlier date for the growth and use of cotton. Smith and MacNeish (66) found fragments of ancient cotton bolls and a sample of woven cotton fabric that date from about 5800 B.C. The floor level of the cave where the fabrics were found dates from between 7200 and 5000 B.C. When the boll pieces were compared with modern bolls of ordinary Upland cotton, there was no significant difference. Smith and MacNeish stated, "no doubt remains that American tetraploid cotton species originated through natural hybridization."

Hutchinson, Silow, and Stevens (38) stated that the art of spinning cotton is much older than the Indus Valley findings indicated. This statement is certainly substantiated by the recent discoveries in Mexico. However, these same writers go on to say "the art of spinning cotton is new in comparison to the spinning of wool and flax," and add, "there can be little doubt that the discovery and improvement of cotton was made by civilized people already well versed in the manufacture of linen and woolen fabrics." The Mexican cave discoveries (66) seem to disprove these deductions. Tests of the Mexican findings should prove of tremendous value to historians in attempting to unravel the age of spinning and, who knows, possibly find cotton's new role in its history.

Andrews (1) suggested that the first linted varieties of cotton grown in the Americas may have been brought from Asia, possibly by a pre-Inca civilization. However, he added that no adequate explanation presently exists of how such people and materials could have been transported. Moreover, the cottons endemic in the Americas are tetraploids (52 chromosomes), while those of Asia are diploids (26 chromosomes), and there is no known record, says Andrews, of the latter occurring in the new world under conditions suggesting they may have descended from such early importations. There is botanical, cytogentic, and archaeological evidence, according to Andrews (1), which indicates that "the American linted species G. hirsutum and G. barbadense are allopolyploid (tetraploid) forms resulting from hybridization between diploid Asiatic and a diploid Wild American with subsequent doubling of the chromosome number."

The North American branch of New World cotton apparently spread from the west side of the northern Andes Mountains, reported Hutchinson, Silow, and Stephens (38), to Central America and Mexico and formed an assemblage of variability in what is now Guatemala and Southern Mexico. From that region, as a center, Mexican and then American Upland cotton formed and spread. Until a 1964 discovery of ancient cotton bolls in Mexico, archaeological evidence of ancient cotton culture had not been found in the Guatemala-Mexico region. Earlier indications were, because of the tropical humidity that had prevailed in the regions of the Mayan and other ancient civilizations of Guatemala and Southern Mexico, all remains of ancient textiles had decayed. The Mexican discovery has since disproved this theory.

When the colonists first came to America, they did not find cotton in what is now the southern United States, wrote Brown and Ware (14). Because of the need of a textile crop suitable to the climate in the southern colonies, numerous cotton stocks were introduced during the colonization period. Some of these rapidly produced cotton crops, but others either did not mature before frost occurred or were altogether sterile. Naturally the more responsive stocks were chosen for future plantings. These selections were apparently further aided by adaptation over the years.

Ware (73) pointed out that it was not until after the close of the French and Indian War, about 1760, that the upland country became occupied by white people. He went on to say that although cotton culture rapidly spread among these new colonies it did not become a commercial crop of any significance until the outbreak of the Revolutionary War, when textile supplies from England were cut off and raw cotton imports from all outside countries were greatly curtailed. The need for cotton cloth, not only for the uniforms of soldiers but for civilian clothing as well, caused cotton culture to expand from the old local areas into the coastal regions of Maryland, Delaware, New Jersey, and into eastern Pennsylvania. After the development of the roller gins, Philadelphia became a market for seed cotton and the center for distribution of lint. After the Revolutionary War, Philadelphia continued as a seed cotton market until the saw-gin was established in the South. New York then became the export market of the saw-ginned lint.

At this time, according to Ware (73), the factory system for the manufacture of cotton textiles was being well-established in England. This development required a long period of growth, even much longer than that of the origin and rise of American Upland cotton in the southern states.

The green seed Upland, previously indicated as of the Coastal Mexico and Central America origin, reported Ware (73), sufficed in the early days of new lands and slave labor, but it did not appear to have the yield, the lint per cent, the size of boll, the disease resistance, the storm resistance, or the length of fiber that were found later to occur in the greyish-white seed stocks from the drier highlands of Mexico. Ware stated that "the introduction of this new Upland stock began in the early decades of the Nineteenth Century, and was said to be of as great further impetus to the American cotton industry as the saw-gin was to the culture of the green-seed type."

Brown and Ware (14) reported that the invention of the saw-gin brought on better responding stocks, and commercial cotton growing began to expand as a result of the accelerated exports of raw cotton to England. The new source of stocks was the plateaus of Mexico and Central America, where annual forms were in culture, developed out of the Guatemala-Southern Mexico center of variability. The introduction of Mexican cotton, beginning about 1800, was a greater boom to the Upland cotton industry than the invention of the saw-gin. Records show that these cottons provided much of the parentage of present-day Upland varieties. Some of the better stocks of the early introductions doubtless were carried over a long time, and apparently much infiltration of these into the Mexican stocks took place. Markings of such infiltration have appeared in certain varieties practically up to the present time.

Andrews (1) suggested that the Upland cottons of the United States were probably derived from the varietal center of G. hirsutum in Southern Mexico and Guatemala. Investigations by Mangelsdorf and Reeves (42) into the origin of maize indicated that in its early development in South America material was transported to Central America, and then for a long time there was no agricultural interchange between the two areas. The same thing could have happened in the case of cotton (1). The long period of isolation in Central America could have provided time for gene substitutions to take place. Some workers have concluded that gene substitutions comprise the only essential difference between G. hirsutum and G. barbadense.

According to Brown and Ware (14), of the two general kinds of ordinary white short cotton known during the colonial period, naked or black seed and fuzzy green seed, the latter apparently proved much better in production and furnished the cotton for which Whitney's gin was invented to separate the lint from the seed.

The Upland name, reported Brown and Ware (14), originated as the colonial settlements developed in the upper country or interior of the Carolinas and Georgia. Cotton was found to be the most suitable source of raw material for making homespuns in that isolated back-country economy.

Brown and Ware (14) reported that cotton for home industry in the southern colonies developed to the greatest extent in the back-country and consisted mostly of the green seed kind. The green seed type, arising as the predominant cotton of the upland country, became known as Upland cotton. . . the Sea Island was known as lowland cotton. Sea Island also was referred to as black seed and the Upland as green seed until the Mexican gray seed and white seed forms largely supplemented the green seed form in the first half of the Ninteenth Century and likewise became known as Upland cotton.

Cultivated varieties of cotton as it is known today are undoubtedly an innovation of the commercial period, particularly of that period corresponding to the era of the factory system of manufacture of cotton goods. Prior to this, reported Brown and Ware (14), the supply of cotton was produced in garden-like plots or was harvested from perennial plants in the uncultivated state. Not much commercial pressure prevailed to increase yields or to improve the kind of cotton produced by singling out more efficient plant groups.

From 1800 to about 1850, Brown and Ware (14) pointed out, the varietal names of green seed stock were Maryland Green Seed and Texas Green Seed. The Mexican introductions were Mexican, Mexican

Burro, etc. Varietal names accumulated more rapidly after the 1850's, and by 1930 a great expansion in the names of varieties had taken place. Along with the rapidly growing list of varietal names came an increase in the turnover of names. Thereby were initiated two general classes into which varietal names could fall: those that applied to more stable varieties, representing the type successions; and those that were mere names representing duplicates of other varieties belonging to the same type or belonging to no particular type at all.

The first known attempt to classify American Upland varieties systematically into types was begun by P. H. Mell (44) around the latter part of the Eighteenth Century at the Alabama Experiment Station at Auburn, Alabama. Stocks of Upland varieties and representatives of some other species were collected from different parts of the cotton belt and from other countries, and were studied and classified with a view to using the better ones in a series of crossing experiments. On classifying the Upland varieties by several methods, Mell found that the forms in his collection having features alike could be arranged in a definite number of groups.

A new classification made by Brown (12) around 1925 was a more appropriate ensemble of the varieties of the early post-boll weevil period. His system was based on fewer characters, principally boll size and staple length. Though more artificial, it served the purpose for grouping the varieties then grown. This classification is shown below:

Group 1.	King type: early, small-boll, short-staple group.
Group 2.	Dixie type: medium-late, small-boll, short-staple group.
Group 3.	Cook type: round-boll, short-staple group.
Group 4.	Triumph type: big-boll, medium-staple group.
Group 5.	Delfos type: small-boll, long-staple group.
Group 6.	Webber type: big-boll, long-staple group.
Group 7.	Various types: mixed, or intermediate group.

With the turn of the century came a vigorous plant breeding era, from which are derived our present day varieties of Upland cotton.

Brown and Ware (14) considered the beginning of the plant breeding era in cotton to be "the re-discovery of Mendel's Law in 1900, the numeration of Johnnsen's pure line theory in 1903, and the work of the first decade of this century of Balls-in Egypt, and Webber and Orton in the U. S. Department of Agriculture."

Ware (74) indicated that the spread of the boll weevil over the cotton belt at the beginning of the century caused a widespread change in the types of cotton grown in the different regions. When the boll weevil struck various areas, it was no longer possible to grow late-maturing varieties. Varieties that had long been famous for high quality but were late in maturing were discarded and early short-staple cottons were substituted. Trice in Tennessee, some of the Cleveland and Webber strains in South Carolina, Mexican and Cleveland strains in North Carolina, and Cook in Alabama served to meet part of the situation when the boll weevil finally infested the southeast.

Varieties are classified by Brown and Ware (14) into 16 types, some containing more than one group or sub-type and often several varieties. These are: Deltapine, Fox, Stoneville, Coker 100, Acala, Empire, Rowden, Mebane Triumph, Western Mebane, Lankart, Paymaster, Macha, Hybrid, Delfos, Extra-long staple Upland, and miscellaneous Upland.

Types were given from the standpoint of development. Some of the more outstanding, as reported by Brown and Ware (14), or more distinctive varieties or sub-types follow.

Deltapine type was developed from a rather complex series of crosses, according to Brown and Ware (14), which were carried out by the Delta and Pine Land Company of Scott, Mississippi. Foster, Express, and Polk of the early post-boll weevil, small-boll, long-staple type and Mebane Triumph of the old weatern Big-boll, or Stormproof, type were the varietal parents.

The earlier commercial strains or varieties, said Brown and

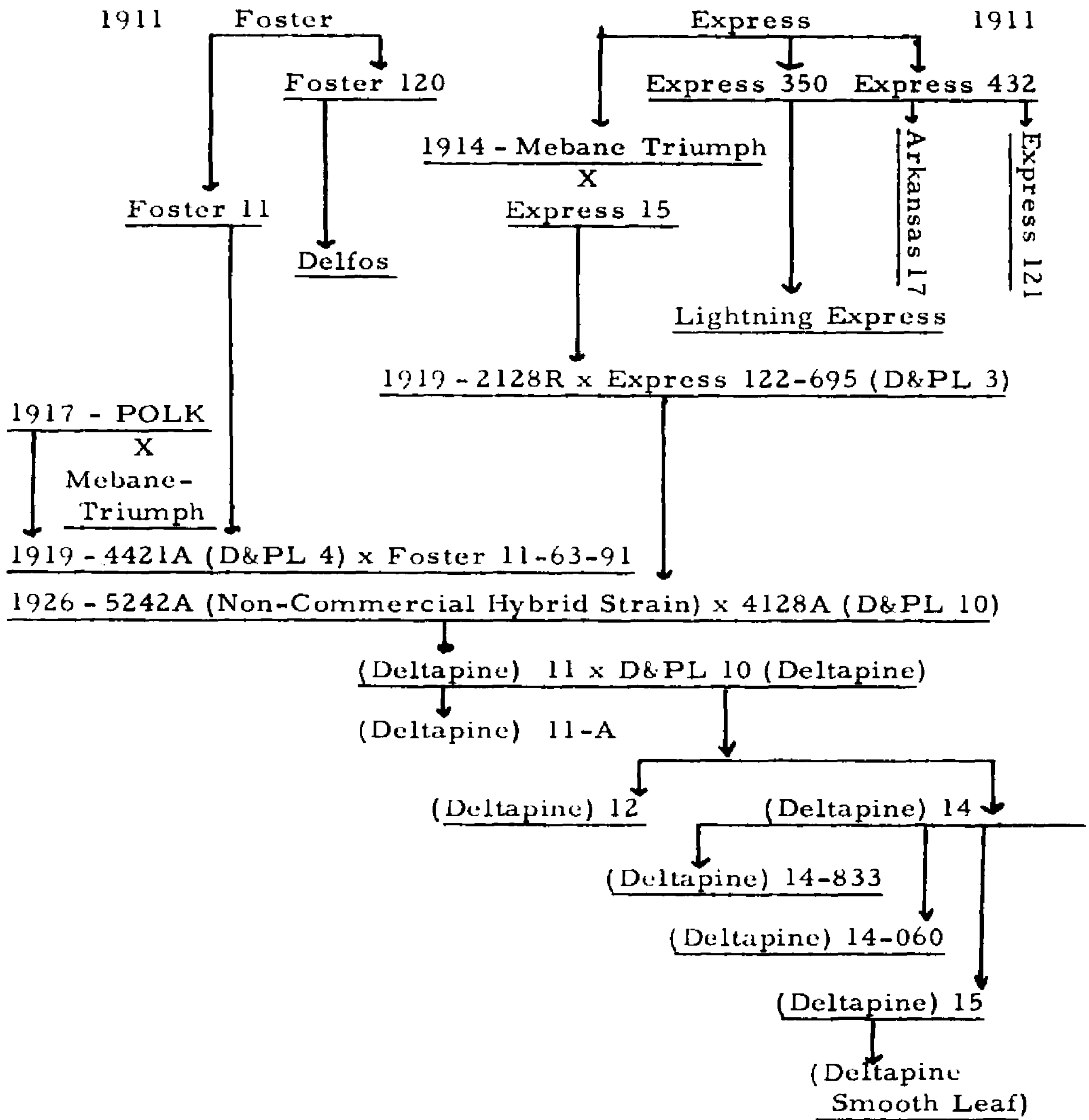
Ware (12), introduced from this series of breeding material were D. &P. L. (Delta and Pine Land) 4, D. &P. L. 8, etc. The last number of the series, D. &P. L. 11, received the Deltapine name and became Deltapine 11. Later Deltapines are numbers 11A, 12, and others. It was introduced to growers about 15 years ago.

Deltapine 15 can be distinguished from Deltapine 14 by having a more rounded boll and stronger and somewhat longer fiber and being slightly earlier, wrote Brown and Ware (14). The foliate of Deltapine 15 has a slightly lighter, more yellowish shade of green than Deltapine 14, and the corollas are slightly longer (see Figure 1 for diagram showing the course of the development of Deltapine varieties).

Fox type consists of a single variety of the same name, reported Brown and Ware (14), and it has the status of a variety. Fox was developed from hybrid material derived from crossing Deltapine 14 and Stoneville 2B. Fox is an early rapid-fruiting variety. As compared with Deltapine 15, it suffers more quickly from drought. With adequate moisture and liberal fertilization, Fox will produce a very large yield. Fox is an early type and has a place in the humid area where a definite degree of earliness is needed. Brown and Ware's plant description was as follows:

> Plants are short with short internodes, few vegetative branches unless plants are widely spaced; foliage light with only a few 5-lobe leaves, moderate pubescence; bolls medium small, slightly pointed; staple length 1 to 1-1/16 inches, tensile strength medium; lint percentage 36 to 38; seed medium to small gray fuzz.

Figure 1. Diagram of the Pedigree of Deltapine Cotton.



Source: Delta and Pine Land Company,
Scott, Mississippi.

Stoneville type is represented by three distinct varieties or sub-types, stated Brown and Ware (14). The current Stoneville varieties, and other Stoneville stocks, have come from one or the other of two of the sub-types, Stoneville 2 and Stoneville 5. Ambassador, or Stoneville 4, was the third sub-type. Successive breeders of the Stoneville Pedigreed Seed Company, Stoneville, Mississippi have been responsible for developing the later Stoneville cottons.

Lone Star 65 was developed from a plant selection made in 1916, stated Brown and Ware (14). This plant was selected out of regular Lone Star of the big-boll, stormproof type. Because of the response of the progeny of that selection, the breeder thought that it must have been a natural cross resulting from pollen having come from Trice of the early King type that had grown nearby. The selections out of Lone Star 65 that formed the basis of Stoneville were made in 1923.

Stoneville 2 was from selection 2 of 1923, reported Brown and Ware (14). Stoneville 2A was selected in 1928 from Stoneville 2, and Stoneville 2B was selected in 1931 from Stoneville 5. These constituted the most important representatives in the Stoneville development. This sub-type has been maintained to the present time as Stoneville.

Stoneville 4B6 which descended from 1923 selection 1, stated Brown and Ware (14), showed considerable departure from the other Stoneville sub-type and was assigned, therefore, another varietal name, Ambassador which was definitely a distinct form.

Stoneville 5 and 5A were varieties of somewhat different appearance and response, reported Brown and Ware (14), which occurred rather early in the Stoneville breeding work. Stoneville 5 and 5A were important varieties in the 1930's. They were earlier than the Stoneville 2 series and had somewhat smaller bolls, but they were higher in lint percentage.

Other varieties, stated Brown and Ware (14), developed from Stoneville stocks by later breeders were: Empire Wilt from Stoneville 2; Bobshaw 1 and Stoneville 20 from Stoneville 5A; Stoneville 62, Stonewilt, Paula, and Arkot 2-1 from Stoneville 2B. Empire Wilt was subsequently described as another type.

Since 1962 the Stoneville Pedigreed Seed Company marketed two selections from Stoneville 7. One, Stoneville 7A, was selected primarily for improved fiber quality. The other, Stoneville 213, was selected primarily for early maturity.

Coker 100 type and Coker 100 WR belong to the same type, reported Brown and Ware (14), but two varietal deviations occurred in this type of breeding material. They were Coker 200 and Coker 100 Staple. The former was earlier and more determinate in growth habit. The latter differed principally in that the staple was longer.

The Coker 100 series was developed by the cotton breeders of the Coker Pedigreed Seed Company of Hartsville, South Carolina, stated Brown and Ware (14). The parent material was a derivative of Lone Star 65 and was obtained from Mississippi in the early 1920's. It was carried in the breeding blocks at Hartsville, and selections were made until 1929 when one of the selections attracted special notice. In 1930 the progeny row from the selected plant showed evidence of hybridity that was thought to have arisen from a natural cross with the Foster variety. Out of this progeny row further plant selection was done, and in the course of reselecting and progeny testing the Coker 100 variety was isolated. Seed of the variety were distributed to growers in 1937. Coker 100 became a popular variety and was very widely grown in the eastern part of the Cotton Belt until 1942 when Coker 100 WR began to replace it.

In the development of Coker 100 WR it was apparent that natural crossing had occurred between breeding stocks of the old type and those of Clevewilt, a variety resistant to fusarium wilt. Brown and Ware (14) reported that, through much selecting in this hybrid material, the Coker 100 type having the wilt resistance was obtained. It appears that Coker 100 WR was the first example of a variety just as well adapted to nonwilt land as to wilt land. Brown and Ware's plant description was as follows:

> Plants erect, semi-determinate, vigorous, and with well-spaced fruiting branches turning up somewhat; foliage thin with medium-sized deeply lobed leaves; bolls round ovate, slightly pointed,

> with 70 to 72 per pound of seed cotton, opening wide and fluffy yet storm-resistant; picking quality good both by hand and machine; lint percentage 37 to 39; staple length 1-1/32 to 1-3/32 inches or longer under good conditions; character of staple excellent, uniform and strong; early and high production; and resistant to the fusarium wilt organism.

The Empire variety of cotton was developed from the Stoneville 2 variety. Brown and Ware (14) stated that it was bred by the U. S. Department of Agriculture and the Georgia Experiment Station, Experiment, Georgia. The parent plant selection was made about 1935. Several plants were selected from the progeny row of the next year, and from these a family of parallel lines ranging within the type has been maintained. The first introduction to growers occurred in 1943 and the variety named Empire after the "Empire State" of the South, Georgia. The variety as a whole was not resistant to the fusarium wilt organism, but on testing the family lines on wilt-infested land some were found to be resistant. In making the following increases only the resistant lines were used. The release of this stock to growers was made in 1948, and the new stock designated Empire Wilt. Brown and Ware's plant description was as follows:

> Plant compact, leaves medium size, early, considering size of bolls; bolls 55 to 60 per pound of seed cotton; staple length 1 to 1-3/32 inches; lint percentage 38 to 41; seed medium size; plant very productive and resistant to the fusarium wilt organism.

H. B. Brown carried on the most extensive systemic work in cotton breeding and improvement in Louisiana, reported Ware (74), when he joined the staff of the Louisiana Agricultural Experiment Station in 1926. In 1927 Brown started variety test work in representative sections of the state. He brought stocks of the breeding lines he had originated and continued while at the Mississippi Station and with the Stoneville Pedigreed Seed Company.

Louisiana has numerous one-variety communities. For all practical purposes, up until recently it could have been considered a one-variety state, growing Deltapine on 85 to 95 per cent of the cotton acreage. Brown and Ware (14) mentioned that production of cotton through a one-variety community offered a way of utilizing the best varieties to maximum extent, of maintaining the seed supply, and of producing relatively uniform cotton in very large quantities.

The following hypothetical schedule for selecting and testing hybrid material was presented at the 1952 Cotton Improvement Conference by E. C. Ewing (29) of the Delta and Pine Land Company, Scott, Mississippi with the year 1970 set as the limit. A hybridization program was to be set up as follows:

Sequence of Steps in Developing
A New Variety

1952	Planning
1953	P^1 for Crossing
1954	F^1
1955	F^2 Plant Selection in Hybrid Blocks
1956	F^3 Plant Selection in Progeny Rows

1957	F^4 Plant Selection in Progeny Rows
1958	F^5 Progeny Row Test
1959	New Strains Test
1960	Advanced Strains Test
1961	Main Variety Test
1962	Repeat in Main Variety Test
1963	Increase 10 Acres
1964	Increase 200 Acres
1965	Increase to 2,000 Acres Producing Foundation Seed
1966	Increase to 20,000 Acres Producing Registered Seed
1967	200,000 Acres Large, Scale Commercial Production

Ewing (29) reported that only one generation would be produced in each year. The F-1 generation would be grown in 1954 and selections made in the F-2 generation in 1955. Back crossing would not be employed. Subsequent selections should be made in hybrid progeny rows of the F-3 and F-4 generations in 1956 and 1957, respectively. Three generations of individual plant selections would have been produced by 1957; then the F-4 selection would be planted in the F-5 generation in 1958 in progeny rows for comparison. A number of these would be selected in that year and carried over into a new strains test of 1959. The most promising strains would be put into an advanced strains test in 1960. In 1961 the more promising ones of the advanced strains test of 1960, would be carried into the main variety test of 1961. After elimination of the unsatisfactory strains the more promising ones would be repeated in the main variety test of 1962. After four years of testing in strains tests and the main variety test, a fair idea would be obtained of the relative merits of the new strains. If any one or more of them appeared acceptable, it would be time to begin increasing the seed of the more desirable types. It is presumed that from the new strains test or from the progeny row selection of 1958, sufficient seed would have been produced to plant as much as ten acres in 1963. The seed from this ten acres should give sufficient planting seed to grow about 200 acres in 1964. In 1965 this could be increased to about 2, 000 acres and at this stage the seed from this 2, 000 acres would be called "Foundation Seed." Registered Seed would then be produced and the seed from this 2, 000 acres should produce enough seed to plant 20, 000 acres for the production of registered seed in 1966. The progeny of this registered seed in 1967 could be considered large scale commercial production. Hence, sixteen years would be consumed in making the cross and testing out the material produced.

Brown (12) wrote that breeding work is necessary to hold varieties up to their present standard or condition, to say nothing of improvements. There is room for definite improvement in the character or qualities of all cottons.

Climatic and Moisture Requirements

Geologists have traced back the earth's history some billion and a half years. Human beings have seen only the more violent moods of the earth. They were not here during the immense stretches of time when it was comparatively quiet and peaceful, so said Richard J. Russell (60) in Climate and Man. According to Russell, no adequate evidence exists of reoccurring climatic cycles nor is there proof that short-time climatic changes are anything more than matters of chance. Many theories have been advanced to account for long-time changes, especially the occurrence of glacial epochs. Some of these theories are, briefly, "changes in the angle of the ecliptic (the inclination of the earth's axis), precession of the equinoxes (a cycle occurring every 26,000 years), variations in the sun's radiant energy as indicated by sunspots, changes in the atmosphere that might affect the amount of radiant energy reaching the earth, changes in the amount of carbon dioxide in the atmosphere, and volcanic dust." In most cases, the cause suggested was not adequate to produce the effect, or there were other serious objections to the theory.

Russell's article (60) mentioned that earth's climate is profoundly influenced by the size of continents and oceans and the elevation of mountains, and these are the very things that are most profoundly affected by crustal revolutions. He concluded that these revolutions somehow produce the glacial epochs--"brief periods when all life on earth is tested to the utmost and has to adapt itself to new conditions or perish."

In Climate and Man, Blumenstock and Thornthwaite (11) stated that a great climatic pattern is made by moisture and dryness, heat and cold, in turn creating a pattern of natural vegetation, and "both together have been the principal forces--though not the only ones--in creating the general pattern of soils."

The settlement of the New World and its Southland was greatly affected by climate. Carl O. Sauer (61) wrote in Climate and Man, "This was indeed a lustier land to which the settlers had come, a land of hotter summers and colder winters, of brighter and hotter sun and more tempestuous rain, a land suited to and provided with a greater variety of vegetation than the homelands of Europe."

Sauer (61) pointed out that neither in New England nor in the South did the early explorers and settlers come primarily to farm. In fact, agriculture was their last thought for means of livelihoods. However, in order to keep from starving, they were driven to farming, and they may well have starved had they not so quickly adopted Indian agricultural methods and crops.

Sauer (61) said, "the European farming methods were entirely unsuited to a densely forested land. The Indians had worked out the best way to farm such a land with a minimum of labor and practically no equipment except a digging stick or mattock. They killed the trees by girdling, burning them, and planted their crops, mostly corn, beans, and squash, in hills among the stumps."

In the southern colonies, Sauer (61) went on to say, two money crops soon came to be dominant. Virginians discovered that their climate was well adapted to the growing of tobacco. This culture eventually spread all the way across the upper South. A second great discovery was that the Southern climate was also adapted to cotton. Cotton growing under the plantation system gradually spread westward across the deep South.

Climate largely determines those parts of the world in which cotton can be produced commercially. Within those regions, wrote Brown and Ware (14), the crop can be produced on a wide variety of soils. However, not all soils are equally suitable for cotton. High levels of production require favorable combinations of climate, soil, and cultural practices. Cotton is presently grown as a commercial crop in certain regions of the new World within the limits of approximately 37^{o} N latitude and about 32^{o} S latitude.

What is commonly known as the Cotton Belt of the United States lies below 37^{o} N latitude, reported Mercier and Savely (45). This embraces the larger part of the following states: Arkansas, Alabama, Florida, Georgia, Louisiana, Mississippi, Oklahoma, North Carolina, South Carolina, Texas, and Tennessee, along with small portions of Virginia and Missouri, plus New Mexico, Arizona and California.

It is now generally agreed, reported Blumenstock and Thornthwaite (11), that the climatic requirements for successful commercial production of cotton are "a mean annual temperature of not less than 60° F. or, under certain otherwise favorable conditions, of not less than 50° F.; or a frost-free season of 180-200 days; an annual rainfall of not less than 20 and not more than 75 inches, with suitable seasonal distribution; and open, sunny weather at least half the time throughout the year."

Blumenstock and Thornthwaite (11) said that weather conditions have a tremendous influence on yield and quality. Cotton thrives best when there is a mild spring with light, frequent showers; a moderately moist summer, warm both day and night; sunny weather during the period of bloom; and a dry, cool, prolonged autumn. On the other hand, unfavorable weather conditions, such as cold wet weather in the spring, may rot the seed, retard seedling growth, and favor cutworms and seedling diseases. Rains that cause the soil to pack or crust at planting time may ruin the stand, and too little moisture may prevent germination. Cold winds, sandstorms, and duststorms early in the season may kill seedlings. Cold nights and hot days while the plants are young favor the cotton. Heavy rains and low temperatures in May and June favor diseases and insects. A wet summer induces too much vegetative growth and favors insect damage. Severe summer drought often stunts the plants and causes too early maturity. Rainy weather at picking time retards maturity, interrupts picking, and damages the exposed fiber. Hailstorms during the growing or harvesting season may do much damage.

Tharp (71) said that usually air temperatures below 60° F. contribute little, if anything, to the growth of the cotton plant, and air temperatures much in excess of 100° F. may be unfavorable to it, particularly if repeated for many days. Yield is almost invariably greater under good cultural practices if means of daily average air temperature are higher than normal for the main part of the growing season (without going above the favorable range for cotton plant development).

The direction of the wind also affects soil temperature, reported Riley, et al. (57). A North wind dropped soil temperature several degrees at Saint Joseph, Louisiana. The color of soil also affects temperature. Dark soils absorb more heat than light colored soils. Temperature is also affected by texture and amount of moisture in the soil.

Minimum temperature, said Riley, et al. (57), for cotton germination is near 60° F., maximum is about 102° F., with the optimum in the 85° to 95° F. bracket.

Research at the Delta Branch Agricultural Experiment Station showed that emergence averaged 93 per cent with a soil temperature of 70° F., about 75 per cent with 65° F., and about 10 per cent with

60° F., as reported by Rose, Baker, et al. (59).

Riley, et al. (57) stated that seed quality is a major factor in the way soil temperature affects seed development. High quality seed was used in the experiment which gave 75 per cent emergence at 65° F. average soil temperature. With seed of average quality, the soil temperature should be around 68° F. For a good rate of emergence with low quality seed, the soil temperature should average 70° F. or higher.

Moisture also greatly affects cotton production in the Mississippi Delta. "The cotton plant makes a fairly high demand for soil moisture, about 562 pounds of water per pound of total plant material. This requirement is 34 per cent higher than that of dent corn," reported Tharp (71), "and only 51 per cent lower than that of alfalfa, grown under similar conditions."

Cotton Economic Research(23) reported that "Twelve to 15 inches of water are required to produce a bale of cotton when the soil contains sufficient organic matter to keep the cotton plants in good physical condition and enough plant food is used. When soils are low in organic matter, in poor physical condition, and no fertilizer is used, twice as much moisture is required to produce a bale." Higher yields require proportionately greater amounts of water. About 65 to 75 per cent of the total requirement for water and plant food must be available to the crop during the bloom period, otherwise a heavy shed may be expected.

Tharp (71) said that the fruiting activity of the cotton plant varies markedly in accordance with total radiation. A relation between prolonged cloudiness and excessive shedding both of small squares and of young bolls has been shown in carefully conducted experiments, together with continued observation and experience.

Riley, _et al._ (57) reported that ever since the beginning of agriculture, the most successful farmer has been the one who has the best understanding of the "calculated risk." In this day of scientific farming, many of the risks such as plant variety, diseases, insects, and weeds have very effective controls. Weather remains the biggest risk without control.

Soil Preparation, Seeding, Fertilization, and Cultivation

Great changes have taken place during the last three decades in cotton culture. None have exceeded the advancement made in mechanization. Beginning about 1930, numerous tractor-mounted attachments were developed. The limiting factors in mechanization in the State of Louisiana were areas of small farms, irregular fields, and steep terraced hill-land. The later condition was one of the major factors responsible for the rapid shift of the cotton acreage from the hill to the terrace and delta sections of the state.

In soil preparation, the first step is disposal of stalks and other debris. Brown and Ware (14) stated that in preparation of a good seed-bed for cotton, proper disposal of vegetation on the land is necessary. Productive crops such as corn or cotton leave a considerable mass of old stalks on the land, and if the land is poorly cultivated, large weed stems, and other weed materials are present also.

Efficient disposal of stalks and debris was very difficult with the animal-drawn plow. Brown and Ware (14) reported that stalk cutters were introduced around the turn of the century, the first being the single-row, animal-drawn type. Later the two-row, animal-drawn type was developed. About 1925 the two-row, tractor-drawn, rolling-type stalk cutter came into use and is still the one used most generally by cotton farmers. On large farms, a squadron of two or three rolling-type stalk cutters was formed by hitching them together so they could be pulled side by side by a large tractor to cut a wide swath at one operation. When the stalks are large and green, further improvement can be achieved with tandem disk harrows hitched behind the cutters. The stalk cutter blades cut across the row while the disks cut parallel to the row. This is a combination more popular with farmers in the West who have two and four tractors. Several types of power-operated stalk cutters and shredders have been introduced which can operate at high tractor speeds. The power take-off of the tractor drives the cutting and shredding knives, and, therefore, they do a much better job of stalk disposal than the heaviest rolling cutters, even when in combination with the tandem disks. The stalks are cut close to the ground and, after shredding, distributed over the land.

Brown and Ware (14) stated that modern stalk-disposal equipment, especially the shredder-type, proved particularly efficient in permitting earlier, more rapid, and more complete disintegration, even when the stalks are green and tough. Green vegetation which has a high percentage of water, if immediately plowed under, will decay more rapidly. The early destruction and plowing under of stalks and other vegetation provides a longer decay period before disturbance in preparing the soil for the next crop. Early disposal reduces the maturation period of weed seeds and provides for earlier planting of winter cover crops. Early disposal, including disintegration of remnant bolls, also is a useful operation in pink bollworm control.

To properly incorporate cover crops in the soil, according to Brown and Ware (14), a second plowing of the land in the spring is necessary. A disk harrow usually can be used to chop up the cover crop before the spring plowing but this is satisfactory only if the stalks and other debris of the previous crop were disposed during the fall. Green cover crops, except in heavy growth, usually are more easily cut up than the matured stalks of the previous crop or old weeds, but double disking in two directions may be necessary to properly cut a heavy or very rank cover crop. When the stalks remain at the chopping up of the cover crop, modern stalk cutters are also quite effective in chopping up the portion of the green manure crop that is in the range of the cutting knives.

Cotton, Smith (67) said, requires a warm, moist, well-prepared, well-drained, clean and firm seedbed for planting, and good germination. The thoroughness of disposal of crop residues, the soil type, the topography of the land, rainfall, power available, and the type of machinery used all influence the number of operations necessary to obtain a good seedbed. Skippy stands reduce the efficiency of mechanical choppers and harvesters and reduce the yield.

Andrews (1) stated that a cloddy seedbed produced by working the soil deep when it is relatively dry and allowing it to settle and mellow for several weeks before planting produces more cotton than does shallow or excessive tillage. The primary value of breaking the soil is to help natural agencies produce good 'tilth'. Excessive pulveration tends to destroy desirable soil structure. The best seedbed preparation for cotton is one that maintains an open granular or crumb structure throughout the crop season.

Methods of preparing the land vary in the different sections of

Louisiana. Soil type with its characteristic structure is the principal factor, according to Andrews (1), that influences seedbed preparation. Middlebusters are commonly used for forming the rows into beds. Before planting, the beds are usually worked to reduce their height and to destroy weeds. The beds may be dragged down, cultivated, or run over with a rolling stalk cutter. The seed are then planted in the clean bed.

Heavy soils in the Mississippi River Flood Plain may be prepared in the fall and light soils in the spring, reported Andrews (1). Planting on a fresh seedbed in heavy soils is usually unsatisfactory and it is difficult to prepare a large acreage of heavy soils in time for wetting and drying to make a good seedbed. For these reasons fall and winter breaking is preferred on such soils. The land may be prepared by bedding or by bedding and rebedding with middlebusters, and by disking prior to middlebusting. On the lighter soils, breaking is generally deferred until early spring. Stubble land is usually flat-broken on heavy and light soils before disking and bedding.

The reason for cultivation has been a subject of some controversy. Christidis and Harrison (18) mentioned that there is great divergence of opinion regarding some of the values of tillage operations. The popular conception is that cultivation serves to give the soil particles a structure conducive to good germination and growth and assists in the extermination of weeds. Besides these two purposes universally recognized, there is a third; the importance of cultivation in conserving soil moisture. The effectiveness of cultivation for the conservation of moisture has given rise to great differences of opinion.

Flat breaking, according to Cardozier (17), is the most thorough method of plowing. All the soil is turned over in one direction. Before the coming of tractors, the mule-drawn moldboard plow, commonly called the turning plow, was the standard tool for this job. With tractor power, either moldboard plows or disk plows are used for flat breaking. Both are effective, but the moldboard plow does a better job of inverting the trash.

For bedding the middlebreaker is most commonly used, stated Cardozier (17). It is more often called a middlebuster, lister, or bedder. It may be either towed or tractor-mounted. However, few towed middlebusters are used today. Most of them are mounted either in front of the rear wheels or to a tool bar on the rear of the tractor.

Rebedding or reversing old rows with middlebusters is by far the most widely practiced method of breaking land. However, reported Cardozier (17), a test in Arkansas on Mississippi alluvial soil indicated that there was no difference in yield from breaking as compared to reversing the rows with middlebusters.

Saveson and Patrick (62) found that large increases in cotton yields have resulted from deep tillage on alluvial soils of the Mississippi River and of the Ouachita River Flood Plains. These increases have been obtained only in years with below-average rainfall during the growing season and on soils with compact layers that interfere with the movement of air and water and limit root penetration.

The areas with pans are usually randomly distributed throughout fields, reported Saveson and Patrick (62). Farmers refer to them as "hot spots." When cotton is grown on these areas, it suffers moisture stress and wilts during summer dry periods, resulting in considerable boll drop and reduced yields.

According to Clower and Patrick (19), subsoiling a Dundee loam soil gave an increase in available soil moisture which was significant at the 1 per cent level of probability. This difference in available moisture was also reflected in the yield of cotton. A difference of 246 pounds of seed cotton per acre, which was significant at the 5 per cent level of probability, was obtained from subsoiling. This difference was measured during a wet growing season.

Cardozier (17) stated that pulverizing the seedbed is a necessity after plowing because of the rough cloddy condition. One of the more common tools is the disk, more properly called the disk harrow. The spiked toothed harrow, the culti-packer, and the row conditioner are also used.

Eaton (27) stated that, in the case of cotton, probably more than any other crop plant, the success of the crop greatly depends on the stand obtained. Cotton seed is rather difficult to germinate, very sensitive to soil or weather conditions, and before or just after germination the seedlings may be damaged by a number of fungous or insect pests. Very poor stands thus frequently occur, and this factor alone may account for a large part of the failures in cotton cultivation.

The method of planting influences the selection of planting date, according to Cardozier (17). For instance, if planting to a stand or hill dropping, almost every seed will have to come up to provide a good stand. Acreage to be planted will also limit the planting date. In order to cover large acreages part of the crop may have to be planted earlier or later than desired.

According to Cardozier (17), soil temperature is affected by several factors: latitude, altitude, soil type, and moisture content. In Louisiana the dark colored soils warm up much more rapidly than the light, white colored soils. The ideal soil temperature for maximum germination conditions of cotton is well above 85° F. However, the remainder of the growing season would then be so short that yield would be drastically reduced. The primary reason farmers are always anxious to plant early is to obtain as long a growing season as possible. Ordinarily, a temperature of 60° F. at a depth of 3 inches for a minimum of three days is considered necessary. But there are other reasons for early planting.

Early planting of cotton affords the plant time to do most of its growing before the usual droughts set in. Cardozier (17) reported that most of the cotton would probably be produced before boll weevils and certain other insects bothered it to a serious degree. There is a considerable saving in expense for insecticides. Hand labor for both chopping and picking is also more likely to be available, and at lower prices, early in the season. By harvesting early, much of the wind and rain that usually lowers the grade of cotton is avoided. The length of fiber appears to be determined early in the development of the boll. If there is plenty of moisture, the fiber will be longer than if the boll development is delayed until late in the summer when there is likely to be less moisture. In addition, early plants have a longer growing season, and, hence, develop larger bolls than later plantings. Not as many immature bolls remain on the stalk when frost comes.

Depth of seeding in Louisiana usually ranges around 1 inch. The depth will vary with soil type and moisture conditions. Christidis and Harrison (18) said, "cotton seedlings are very delicate and experience great difficulty in reaching the surface of the ground if sown deeper than three inches." This is especially so when heavy rains follow sowing, causing the soil to become very compact, or causing a hard crust to form on the surface. Under such conditions, seedlings may never appear above ground, even when planted at a depth much less than 3 inches. The depth of sowing is of considerable importance in securing a satisfactory stand. It should be as shallow as moisture conditions permit.

Research has shown no difference in yield in plant populations of 13,000 to 65,000 plants per acre, according to Tharp (71). When cotton plants are grown in dense stands, their seasonal patterns of both vegetative and fruiting development differ strikingly from those of plants grown without competition. This affects certain components of yield and some properties of lint and seed. Crowded plants usually produce more total plant material per acre than widely-spaced plants. Their internode length may average greater, the plants are often (although not always) taller, and the canopy of leaves is more dense. Crowded plants bear few, if any, vegetative branches and bear their fruiting branches higher on the main stem.

For these reasons, said Tharp (70), a plant population of 35,000 to 45,000 plants per acre is more desirable in a mechanized operation because it improves mechanical harvesting efficiency and weed and grass control.

Cotton is not hard on the land. Romaine (58) reports that there are areas which have grown cotton almost continuously for 75 to 100 years and still produce high yields. He reports that a bale of cotton and seed removes approximately 35 pounds of nitrogen, 14 pounds of P_2O_5 and 13 pounds of K_2O. The phosphorus and potassium harvested in crops depletes the soil of these elements. The removal of phosphorus and potash in crops reduces the supply of these elements in the soil, and thereby reduces the fertility of soils low in these elements.

Tharp (71) reported (Table I) that 54 pounds of nutrients have been taken up at the first white bloom stage 65 days after germination.

Brown and Ware (14) suggested that the practice of clean summer culture permits erosion in humid areas, with the soil and nutrient losses generally increasing with rainfall and land slope. During open southern winter rains in the humid areas also leach out nutrients unless some fall crop is planted to take up, or partially take up, this loss by winter growth.

Crop rotations are less common with cotton, particularly in Louisiana, than in areas where a general type of farming is followed. Because of weed and grass problems, farmers have been reluctant to rotate cotton with corn, soybeans, or hay.

Green manure (or cover crops) has declined rapidly in acreage since World War II in Louisiana and other southern states. McNair and McKee (43) reported that in 1933 only 6 per cent of the cropland

TABLE I

ACCUMULATIVE NUTRIENT UPTAKE PER ACRE OF COTTON PLANTS PRODUCING LINT AT THE RATE OF A BALE PER ACRE (71)

Phase of development	Approximate time since planting	Approximate quantity of nutrients contained in: Stems and leaves	Squares and bolls	All above-ground parts
	days	pounds	pounds	pounds
Seedling	30	3	None	3
Squaring	45	6	None	6
First white blooms	65	52	2	54
Peak bloom	90	93	13	106
First open bolls	120	296	153	449
Harvest	150 or more	272	266	538

surveyed was in cover crops, but that a marked increase in acreage of these crops took place during the period 1936 to 1940. However, during World War II a sharp decline occurred and since that period the reduction has continued.

A report by Rose, Baker, <u>et al.</u> (59) reported that winter legumes, in addition to adding nitrogen to the soil, improve the physical condition of the soil by increasing the organic matter and the aggregation index of the water-stable aggregates. Also reported was the fact that soils where no cover crops were grown showed greater susceptibility to compaction than soils from plots where cover crops were grown.

The plant food element most frequently added to cotton is nitrogen, stated Cardozier (17). Plants do not take up elemental nitrogen. They absorb it in the form of nitrates or ammonia, mostly nitrates. When ammonia is added to the soil, some of it may be absorbed as the ammonium ion. Most of it, however, changes to nitrate in the soil. While nitrate nitrogen is easily absorbed by plants it is also lost from the soil just as easily. Nitrogen promotes the development of the green color in plants and causes rapid healthy growth. Too much nitrogen, said Cardozier, without enough of the other elements, can cause the plant to produce big stems and leaves and cut down on the production of cotton. When there is a shortage of nitrogen the leaves turn yellowish green and eventually dry up and fall off. Cotton can stand a lot more dry weather if it has a good supply of nitrogen.

Another primary plant food element needed by cotton is phosphorus. "Phosphorus is found in every part of the plant. Its most important use is in cell division, which is the basis of growth. It is also important in the development of the seed and the lint, and hastens maturity," reported Cardozier (17). A plant suffering from phosphorus deficiency is dark green or purplish green and stunted in appearance. Seedlings grow slowly and maturity is delayed.

The third primary plant food element needed by cotton, wrote

Cardozier (17), is potassium. "Potassium is found in the soil in combined or compound forms. When speaking of potassium in fertilizer, it is called potash." It is more stable in the soil than nitrogen, but not as stable as phosphorus. Potassium helps prevent too much vegetation. It is also important in developing the plant's ability to resist disease and insects and to withstand cold wind and other adverse weather conditions. A potassium deficiency is known as cotton rust. First, the leaves turn yellowish green. Yellow spots appear between the veins, and eventually turn black. The edges of the leaves die and become black. Finally, the whole leaf dies and falls off. In very severe cases the whole field may shed all its leaves.

Two of the secondary elements to be considered are calcium and magnesium. Brown and Ware (14) said that calcium in the form of lime or ground limestone is necessary to raise the pH level on all more strongly acid soils. Although magnesium leaches more readily, its loss generally is less than that of calcium. Where heavy calcic lime applications have been made and the pH level is naturally high, existing magnesium is less available. However, where dolomitic limestone is used the magnesium requirement is met.

According to Peevy and Brupbacher (51), some sources of lime contain 8 to 10 per cent magnesium carbonate and 80 to 90 per cent calcium carbonate. This type of lime would generally supply all the magnesium that a soil needs.

Lancaster, *et al.* (41) stated that the minor elements essential to cotton production are boron, manganese, iron, copper, zinc, and molybdenum. Boron is now found to be quite deficient in some soils. Borax as a fertilizer has been found to be a relatively cheap source of boron for correcting this deficiency. A small amount of borax is required, but a larger amount may be toxic. Liming soils tends to make boron less soluable.

The terminal growth shows first indications of boron-deficiency symptoms in cotton, according to Cooper and Donald (20). The terminal bud often dies, causing much branching and dwarfing of the plants. The young leaves turn yellowish green, and when the boron is at a very low level, flower buds become chlorotic, the bracts flare open, and the buds drop from the plant.

Manganese, a minor element, is present in all soils, said Cooper and Donald (20), but under certain conditions it becomes unavailable or available in such small portions that crops in these areas fail to receive a sufficient quantity of it and develop growth disorders. Such symptoms are not commonly observed in cotton, the occurrence being only on certain soil types or where large quantities of liming materials have been added. A more common manganese disorder in cotton, however, results from a water-soluble excess which becomes toxic. Neal and Lovett (47) reported this condition as occurring on a very acid Lintonia and Oliver silt loam soils in Louisiana and Arkansas. Moderate liming is the control measure, but too much lime may cause manganese deficiency in the more sandy soils. The symptoms of the toxicity disorders are referred to as "crinkle leaf".

As far as placement is concerned, the National Joint Committee on Fertilizer Application (55) recommended for the Mississippi alluvial area that fertilizer applied to cotton at planting time should be placed in narrow bands approximately 2.5 inches from the seed row and 2.0 to 2.5 inches below the level of the seed. The side placement or banding of fertilizer can be accomplished simultaneously at planting. This operation is sometimes performed during seedbed preparation.

For anhydrous ammonia, the National Joint Committee (55) recommended sealed placement 6 to 8 inches below the seed, and stated that when rates of anhydrous ammonia up to 60 pounds of nitrogen per acre are sealed 6 to 8 inches below the seed row, there is little danger to germination or seedlings.

Sturgis (69) said, "The native fertility of soils in harvested crops in Louisiana is not generally being improved. The soil organic matter is not increasing or is barely being maintained. It is commonly too low to support the desirable colloidal aggregation necessary for better aeration, root penetration, and moisture storage and movement.

Presently one must depend largely on more liberal use of fertilizers to increase yield per acre."

Weed Control

Weed control in cotton production has been, until very recently, next to harvesting, the most costly operation in cotton production. A cotton production cost chart by Woolf (77) showed in 1963 that weed control costs Louisiana farmers approximately 16 dollars per acre.

Klingman (40) stated that weed control is one of the most expensive steps in crop production. As old as agriculture itself, and in a way of life that has learned to control almost everything, it is of scientific interest that man has accomplished so little in solving the weed control problem. Man finally learned to mechanize and use power in his fight. Now, chemical energy is replacing mechanical energy for weed control.

Klingman (40) defined a weed as "a plant growing where it is not desired, or a plant out of place." Weeds cause great losses in cotton by competing with the crop for water, light, and mineral nutrients. Weeds also impair cotton quality and harbor insects and fungous pests that attack the cotton plant. In other words, weeds lower yields, reduce human efficiency, and reduce the efficient use of land.

Crafts and Robbins (25) mentioned that a distinction should be made between control and eradication of weeds. In some situations, it may be possible and desirable to eradicate a certain weed that is limited in extent. In other situations control may be the only feasible objective.

As to the amount of weed control necessary, Nutt (48) pointed out that the most efficient cultivation is usually just enough to destroy the weeds.

Christidis and Harrison (18) stated that it is doubtful whether tillage after sowing serves any other useful purpose besides destroying weeds.

Harris (33) found that after 13 years with no cultivation, more cotton was produced at less cost. With the advent of suitable selective herbicides in recent years, many producers have become interested in producing cotton with no cultivation. In 1950 an experiment was initiated at Mississippi University to evaluate the efficiency of current pre-emergence and post-emergence herbicides in controlling weeds in cotton without cultivation. In the non-cultivated plots, a row spacing of 28 to 30 inches apart was the most satisfactory. The cotton plant populations per acre varied from 66,000 to 100,000 plants, according to row widths planted. Approximately 85,000 cotton plants per acre resulted in the best weed control and yields. Cotton plants on non-cultivated plots produced blooms 4 to 5 days earlier than those on the cultivated plots. In dry years the non-cultivated plots did not show moisture deficiency as soon as those cultivated. The difference was 10 to 12 days. The cotton plants on the non-cultivated plots tended to have deeper root systems (1 to 2 feet deeper on dry years) than the cultivated plots. Annual weeds were satisfactorily controlled in the non-cultivated cotton by a broadcast application of a pre-emergence and post-emergence herbicide. The cost of weed control by herbicides without cultivation was 3 dollars and 41 cents less per acre than the cost of weed control by cultivation and hand hoeing. Weed control with herbicides and without cultivation returned 6 dollars and 58 cents more than was the case with cultivation and hand hoeing. Cotton weeded with pre- and post-emergence herbicides without cultivation produced 572 pounds per acre more seed-cotton than that weeded with cultivation and hoeing. The non-cultivated cotton plants fruited earlier and withstood drought longer than the cultivated cotton plants. Mean yields and net returns per acre for 13 years of weeding with herbicides with no cultivation were better when compared to the weeding and cultivation and hand hoeing of cotton. The difference was highly significant.

Rose, Baker, et al. (59) reported that many methods of weed control are employed by the cotton farmers of Louisiana. They include rotation, mechanical cultivation (sweeps and ground-driven rotary hoe), hoeing, geese, flame cultivation, and , at present and probably most important, chemical control.

Rotation is one of the easiest, most effective, and cheapest methods of keeping weeds down, according to Rose, Baker, et al. (59). However, cotton for the most part is a cleaning crop and any benefit as a result of rotation should be attributed to causes other than weed control.

Sweep cultivation has long been one of the primary methods of weed control in cotton. Gull and Adams (32) reported that sweeps are still used extensively for cultivating the middles of the rows. The number of mechanical cultivations needed is governed by weather conditions and recurring germination and growth of weeds. Sweeps are also used for cross-plowing. "They are used to plow out sections of the row of plants as the tractor is driven across the rows. Some farmers plow out a section 18 to 20 inches wide and leave a 4- to 8-inch section of plants, while others plow out 36 to 40 inches and leave 10 to 14 inches."

Another mechanical tool which is often used for controlling weeds and grasses, stated Andrews (1), is the rotary hoe. The rotary hoe not only breaks the surface soil crust about the young cotton plants and destroys many small weeds, but it also serves as an excellent fender to keep large clods of soil from falling on the young cotton plants being cultivated by sweeps. The rotary hoe is normally used when the cotton first emerges from the soil. Its use in the Delta is becoming more limited with the adoption of modern chemical weed control programs.

Hoeing is still necessary on most of the cotton acreage planted in Louisiana. Woolf (77) reported in his study, "Cotton Production Costs in Louisiana," medium and large farms may reduce their hoeing costs from 12 dollars per acre to 45 cents per acre by the use of herbicides and advanced technology. Hill-dropping or planting to a stand has eliminated to a great degree the need of the chopping operation. The field is hoed anytime it is overgrown with weeds. However, with the use of pre-emergence, post-emergence and flame weed control, two light hoeings or one hoeing and one flat weeding is the most commonly used weed control program at present.

The use of geese for weed control in Louisiana and the Mississippi valley has given varying success. Under certain conditions, reported Heffner (34), geese can do a thorough job of weeding the rows. With proper care, a large percentage of hoeing may be replaced by the use of geese. On the average it takes from one and a half to two geese per acre to keep cotton clean. They are bought as goslings in the spring and are about 10 weeks of age when put in the cotton. Only enough geese to keep the grass eaten down should be kept in the field. Geese do not eat broadleaf plants until they have run out of grass then they will eat the cotton. There are several disadvantages to the use of geese. Certain insect poisons used on cotton will kill geese. There is also danger of loosing them from attacks by dogs.

Williamson, Wooten and Fulgham (76) stated that flame cultivation is another method of weed control which has become quite extensive since the close of World War II. The flame cultivator consists of a fuel tank, feed lines, control valve, and burners. It is usually four-row mounted on rear of tractor with skids to support the burners. A burner is supplied for each side of the row. Butane and propane, or a mixture,are the commonly used fuels for the flame cultivator. Cotton should be 6 to 8 inches in height and about 0.2 inch in diameter at the ground, before flame cultivation is begun. A four-row flame cultivator will cover 30 to 40 acres per day. Costs for fuel, equipment depreciation, and operation are approximately one dollar per acre.

Chemicals are among the most recent and promising additions to the methods of weed control in cotton. Klingman (40) wrote that chemical weed control began just after World War II, and has since experienced tremendous growth. It is not the final answer to weed problems, but if handled properly, it can do much toward cutting down hoeing costs, maybe eliminating them altogether. "Chemical weed control is classified into three categories: pre-emergence applications, before the seedling comes up; post-emergence, after the seedling has emerged; and, lay-by application, at the time the cotton is layed-by or cultivation is halted."

Porter, Thomas, et al. (52) reported that pre-emergence weed control materials should be applied along with the planting operation; however, they may be delayed as long as two days afterwards. On a well-prepared seedbed the chemicals will control weeds on the area to which applied for as long as 3 to 6 weeks after planting. The chemicals kill seed of annual weeds near the surface.

Porter, Thomas, et al. (52) stated that Diuron and CIPC are the two chemicals currently recommended for use as pre-emergence herbicides on cotton in Louisiana. The chemicals perform equally well. CIPC's cost to the producer is double that of diuron's, so 90 per cent of the pre-emergence herbicide used on cotton in the state is diuron. In using a pre-emergence treatment, the farmer should follow proper seedbed preparation and hill-drop the cotton seed 10 to 12 inches apart at a rate to give 4 to 6 seed per hill. The most common spacing at present is 4 plants per hill 12 to 14 inches apart.

According to most indications, as reported in the "Weed Control Handbook for Mississippi " (75), chemical weed control works best on soils that are low in organic matter and that have a low pH and a high moisture content. Moisture is especially important. Without it the chemical cannot act. The chemical materials remain in the soil for some time killing weeds and grasses as they emerge. Some weeds such as Johnson grass, nut grass, morning glory, and a few others are not entirely controllable.

According to Porter, Thomas, *et al.* (52), post-emergence chemicals currently being used are herbicidal oil, diuron with surfactant or wetting agent, DMA (disodium monomethylarsenate) with surfactant. The herbicidal oil is the only post-emergence treatment currently recommended, although the other two materials were used on a fairly large acreage in 1963. Herbicidal oil has been a recommended practice in Louisiana for a number of years. Only naphtha-type oils which do not have a fortifying agent are recommended.

Herbicidal oil kills by direct contact, reported Porter, Thomas, *et al.* (52). Because of the waxy surface and tissue composition of young cotton stems, cotton is not damaged unless some of the oil contacts the leaves or the bud or the young plant. Oil applications must be stopped when the cotton is about 5 or 6 weeks old, or approximately 8 to 10 inches in height. At that age, the bark of the stems begins to crack and form scar tissue. Oil will penetrate the scar tissues of the stem and kill or seriously injure the plant. Oil may be applied when the plants are from 7 to 10 days old. One or two oilings is a common practice. The oils are normally applied during cultivation by one or two nozzles spraying from each side of the row. Seven to 10 gallons of oil per acre are applied at a cost of approximately 1.4 to 2.0 dollars.

According to the "Weed Control Handbook of Mississippi" (75), lay-by application is being used more and more in mechanized cotton production. Diuron as a lay-by herbicide is most commonly used. This practice has not shown an economic gain. Cotton quality and yield have not been improved where the lay-by application has been used. However, late-season weeds and grasses definitely are controlled.

As can be seen, the problem of weed control in cotton is complex. It is currently impossible for a farmer to carry out a single practice that will work satisfactorily for all situations. The method of weed control to be used in a particular field and a particular situation is up to the operator. To make this decision, reported the State Weed Committee of Mississippi (68), the operator should be thoroughly familiar with his farm in relation to soil type, kinds of weeds, available equipment, monetary resources, capability and capacity of labor resources, and with his own managerial ability.

Disease Control

The Cotton Disease Council (21) describes losses due to cotton diseases as "astounding." The average annual yield loss from diseases is about 2.2 million bales, according to a Council estimate. "The seedling blights are the most widespread and the most consistently destructive of the parasitic diseases."

There are a number of seed-borne and soil-inhabiting fungi and bacteria which cause seedling diseases, reports Presley (53). These diseases are most harmful during periods of cold damp weather. Some of the diseases are damping-off, sore-shin, and seedling blight. The main disease-producing organism primarily responsible for damping-ff in the Mississippi valley area is the Rhizoctonia sp. Cotton seedlings are also attacked by organisms causing bacterial blight. Most of the organisms that damage seedlings also affect cotton plants at later stages of growth.

The most practical method for control of seedling diseases, said Presley (53), is proper treatment of the seed with a recommended disinfectant. It is also well to delay planting in the spring until temperatures are favorable enough for rapid plant development.

At the time of Presley's report in 1955 (53), no satisfactory chemical or fungicidal control measure had been developed for sore-shin in cotton. However, he did say that certain cultural practices would reduce losses. These include planting on well pulverized, raised seedbeds, use of certified seed treated for control of seed-borne diseases, delaying of planting until the soil warms up, and speeding up germination by using reginned or acid-delinted seed and liberal fertilization.

Sinclaire, McCormick, Melville and Sloane (63) found that sore-shin can be controlled by: using top quality seed, seed treatment, and soil treatment.

Fusarium wilt fungus is, according to Jones and Tipton (39), associated with root-knot nematodes, forming a complex whereby the wilt fungus enters the cotton roots mainly through the wounds caused by the nematodes. Once inside the root, the fungus moves upward through the stems to the woody parts of the plant. Symptoms usually appear about the last of June or in early July. Maximum development of the disease is favored by relatively high soil temperatures and moisture.

Smith (65) reported that the first external evidence in larger plants is usually yellowing of the edges of the lower leaves in an area midway between the main veins of the leaf. The yellowing spreads in the leaf. Whole plants become bare, stunted, or die back considerably.

Verticillium wilt of cotton is another disease found in Louisiana which is caused by a soil-borne fungus. According to the Cotton Disease Council (21), plants may be attacked at any stage of development, especially during cool wet weather. The disease causes stunting of the plant and damage to the cotton fibers. When cotton plants are attacked by verticillium wilt the leaves become yellowish and dry out rapidly. The plants also display a mottled marking, first in the lower leaves, which spreads to the middle and upper leaves later in the growing season. Verticillium is difficult to distinguish from fusarium under field conditions. Control measures include a combination of fallowing and rotation of more severely infested fields. Tests in Arkansas showed that some control of this fungus was obtained through shallow cultivation and the use of a balanced fertilizer.

Nematode injury in some areas of Louisiana has been quite extensive. Several species of nematodes, microscopic eel worms, are injurious to cotton plants. Smith (65) stated that the most important of these is the root-knot nematode which enters the roots and feeds from the inside. The reniform nematode is also harmful, and there has been some indication of an association between the reniform nematode and verticillium wilt. The application of soil fumigants and the use of nematode resistant crops in rotation with cotton are considered beneficial control measures. Fumigants such as ethylene, dybromide (Dowfume W-40) at the rate of 6 to 8 gallons per acre a few days before planting will give control until the plant is established and growing rapidly.

Potash hunger or "rust" is a disorder occasionally found in Louisiana. It is caused by a deficiency of potassium and can easily be controlled by the application of potash to the soil.

Boll rot is one of the most serious and least controllable diseases in Louisiana and Mississippi. Boll rot damage is not new in Louisiana. In the early 1900's Edgerton (28) estimated from 5-year's observation in the state, the actual loss from all boll rot to be between 5 and 10 per cent, although there was great variation from year to year.

Presley (53) stated that the same group of organisms that affects cotton seed germination and the growth of seedlings attacksthe cotton bolls causing them to decay. These parasitic organisms may be grouped in two classes, the primary invaders that penetrate the uninjured boll and the secondary invaders that enter through the wounds or openings made by the primary organisms. In the first group are the fungi-causing anthracnose and the bacteria causing bacterial blight. The second group is composed entirely of a weakly parasitic or saprophytic fungi.

One measure which may help to control boll rot, as reported by Brown and Ware (14), is to avoid the use of bushy or leafy varieties in areas where vegetative growth may be excessive. Avoid using excessive amounts of nitrogen fertilizer and over-irrigation. Preventing growth of late-season weeds and grasses which tend to retard aeration and drying of the bottom boll zone of the plants will help.

Defoliation of the lower parts of the plant, and control of insects and other causes of boll injury also help. Planting seed may be treated with a disinfectant. If growth is rank, the whole plant may be defoliated as boll maturity permits. Crop rotation is advisable, as is use of varieties having the most resistance to bacterial blight and other organisms that provide entry of decay fungi.

Boll rot is especially severe in Louisiana when frequent rains maintain high humidity and cause rank growth. In certain adverse years farmers in this state have lost up to 50 per cent of their cotton crop from boll rot and weather damage.

Insect Control

Insect control in cotton production has come to be one of the most costly practices. Christidis and Harrison (18) reported that it is commonly known that plants under cultivation are more susceptible to attack by various pests than when grown in the wild state. When large areas of land are cultivated to plant species, an unlimited food supply is provided for particular organisms having a taste for that crop; natural enemies harbored on other plants are also destroyed or driven away.

Rainwater (54) stated that the cotton field is a haven for insects. Hundreds of species of insects have been identified from collections made in cotton. Some of them feed on other plants, others attack the pests themselves, while others exist without damaging the crop. The number of insects known to cause damage to cotton is large.

According to Brown and Ware (14), over a 25-year period the principal states of the old cotton belt have averaged a loss of over 100 per cent of the crop annually to insects.

The boll weevil (Anthonomus grandis) has been the major pest of cotton in the United States since the early 1900's. It was first observed in this country near Brownsville, Texas in 1892, and in about 20 years had spread over the larger part of the cotton belt of that time. The boll weevil hibernates in the adult state in wood trash, grassy ditch banks, surface litter, buildings, etc., adjacent to or in cotton fields. The mortality of the weevil in hibernation is usually very high over most of the cotton belt, reported Gaines (32). At Tallulah, Louisiana an increase in the number of days on which the temperature fell below 20^{o} F. from September to March decreased the number of weevils found in the cotton field in May and June. In some portions of the cotton belt the temperatures drop so low in most winters that very few weevils survive and they are seldom found in these areas until after migration starts in late July or early August.

Rose, Baker, et al. (59), reported that records at Tallulah, Louisiana showed more than a 100 per cent increase in the average number of weevils hibernating in the fall, and an even more significant figure was the 249 per cent increase in the average number of weevils surviving the winter. There were 3.5 times as many weevils entering the cotton fields now as there were 13 years ago, as indicated by these same records.

According to Mercier and Savely (45) there are four stages in the life cycle of the weevil. They are: the egg, the larva, the pupa, and the adult weevil. Three stages, the egg, the larva, and the pupa, are passed inside the cotton square or boll. The female weevil deposits her eggs in a cavity formed by eating into a square or boll. In a few days a small, white, footless grub or worm hatches from the egg and begins to feed, and makes a larger place for itself as it grows. When the grub or larva sheds its skin the pupa appears and, in this stage, it is inactive and takes no food. A few days later the pupa sheds its skin and the full grown weevil appears. In two or three more days the weevil eats its way out of the square or boll and, about one week later, is ready to start another generation.

Weather affects boll weevil infestation more than does any other factor. Summer weather, high temperatures and heavy rains combined, must be present to produce a great infestation. The boll weevil, according to Brown and Ware (14), has been the greatest single factor in causing shifts of emphasis in practices on cotton production in the United States.

Ewing (30) wrote that the bollworm (Heliothis armigera) and tobacco budworm (Heliothis virescens) are frequently found associated. It is not possible to distinguish between the two species in the field, and the damage done by them is identical. The tobacco budworm occurs more frequently in Louisiana and states east of the Mississippi River. Prior to the entrance of the boll weevil into this country, the bollworm and cotton leafworm were the most destructive pests of cotton. The bollworm, known also as the tomato fruitworm or corn earworm, feeds on at least 70 species of plants. Three and four generations will usually occur in cotton. It has an enormous capacity for reproduction. An individual female may deposit as many as 3,000 eggs.

Pate and Brazzel (50) found that the bollworm and tobacco budworm showed a definite resistance to DDT in tests conducted throughout Mississippi in 1963.

Curl and White (26) stated that the pink bollworm (Pectinophora gossypiella) was first found in cotton fields in the United States in 1917. The early infestations were eradicated, but as more cotton was planted near the Mexican border, apparently in the range of flight of adult moths from the Laguna and other cotton districts of Mexico, eradication became less simple. Part or all of six cotton states, Arizona, New Mexico, Texas, Oklahoma, Louisiana, and Arkansas, are currently infested with pink bollworm.

The pink bollworm lives primarily on cotton, according to Curl and White (26). It lays its eggs on a green boll or other parts of the plant. The larva hatches and immediately bores into the boll and attacks the seed. As soon as the content of one seed is eaten it enters the adjacent one. As a rule, the larva works within the lock, but it may drill a hole through into an adjoining lock and enter. It never leaves one boll to attack another. There may be as many as six generations during one year.

The greatest damage done by the pink bollworm, wrote Brown and Ware (14), is to the lint and seed, yield and quality both being reduced. Control measures are both natural and artificial. Insecticides that have been used successfully are benzene hexachloride and DDT. Regulatory programs used have been strict quarantine of infested areas, seed sterilization, burning of the gin trash, and destruction of stalks and other field debris by a certain date in the fall.

The cotton leafworm (_Alabama agrillacea_) was once a serious pest, but now can be readily controlled with insecticides, reported Rainwater (54). The leafworm caterpillar feeds exclusively on cotton. "The adult lays bluish-green eggs singly on the underside of young leaves. The eggs hatch within a few days and the small worms feed on the underside of the leaves." The leafworm destroys the cotton leaves before the crop is matured. Benzine hexachloride, toxaphene, and calcium arsenate are all effective controls of this insect.

There are a number of species of sucking or piercing insects and spider mites that attack cotton. These are thrips, aphids, fleahoppers, plant bugs, stink bugs, spider mites, and cotton stainers.

Thrips, Andrews (1) said, often attack cotton in the seedling stage. They feed on terminal buds. Thrip injury to young cotton increases vegetative growth and delays fruiting. Cotton usually outgrows early-season thrip injury and produces a normal crop if it is protected from other insects. The most severe thrip damage usually occurs where cotton is planted after turning under a cover crop, or when it is grown adjacent to small grains or onions. Thrips may be controlled by the use of insecticides.

Two types of aphids attack cotton, according to Brown and Ware (14). The most important specie is *Aphis gossypii.* One type attacks the roots and the other attacks the tops or the above-ground portion of the plants. The type that attacks the above-ground portion is worldwide in distribution and attacks many other hosts. Multiplication is rapid. The aphid usually feeds on the underside of the more succulent leaves and young stems. The aphid's secretion, called honeydew, sometimes covers the entire plant, thus lowering the quality of the cotton.

The cotton fleahopper (*Psadlus seriatus*), stated Annand (2), is found in all cotton-growing states, but has damaged more in Texas, Oklahoma, and Louisiana. The young and adult fleahoppers attack the tiny squares, causing them to turn brown or black and fall off. Other host plants for the fleahopper are goatweed, evening primrose, and other weeds. The yield is reduced materially in fields where fleahoppers damage cotton throughout the season. The plant may produce a full but late crop if infestation lasts only a short period. Sulfur was the first material used extensively for fleahopper control.

Brown and Ware (14) reported that spider mites (*Tetrangchus telarius*) are pests of many crops, fruits, ornamentals, and weeds. These mites are barely visible with the naked eye. Their coloration may be red, reddish yellow, yellow, or greenish. When present in cotton, spider mites occur on the underside of the leaves, usually the older leaves on the lower part of the plant. Their life cycle is short which allows outbreaks to develop rapidly. The use of an effective miticide is necessary when severe outbreaks occur.

Rose, Baker, *et al.* (59) reported that there are a number of parasitic predatory insects which attack cotton insects. The mortality caused by these predatory insects is not constant, and other means of control of the cotton insects must be employed. Birds are also helpful because they sometimes feed on insects.

According to Rainwater (54), net returns of over 20 dollars for every dollar spent for insecticide have frequently been obtained by the cotton farmer. In years of heavy insect infestations, the difference between profit and loss depends entirely on whether insects are controlled.

Defoliation, Desiccants, and Harvesting

Chemical defoliation of cotton was accidentally discovered by a worker at the Pee Dee Experiment Station near Florence, South Carolina, in the late 1930's, reported Brown and Woodall (16). Calcium cyanamid was being used to fertilize cotton and some of it drifted onto mature dew-wet cotton causing the leaves ultimately to fall from the plant. Following this discovery, research indicated that it was both possible and desirable to remove the leaves from the cotton crop prior to harvest. Interest in defoliation was intensified in the 1940's when it was found that mechanical pickers were not operating at peak efficiency in rank leafy cotton.

The dropping of leaves from natural causes is associated with a number of conditions such as killing frosts, drought, nutrient starvation, and severe insect infestation.

Just what causes defoliation is not known. Scientists do know, however, that at the point where the leaf petioles attach themselves to branches, very rapid growth takes place, causing the leaves to drop. This is called "abscission." Certain chemicals will cause this special layer of cells to develop. When chemical defoliants are applied properly, stated Audus (3), only the leaves drop off and other parts of the plant are not harmed.

Brown and Woodall (16) said that there is a difference in the terms defoliation and desiccation. Desiccation means a drying out. When certain chemicals are applied to cotton, the leaves dry up but reamin on the plant. The same thing happens when a freeze comes before a frost in the fall. Frost causes leaves to crop, but a freeze desiccates them without their being dropped. When chemical desiccants are applied, the leaves stick on the plant.

Andrews (1) reported that defoliation of mature cotton plants is beneficial for both hand and machine harvesting. The bolls are exposed to the sunlight when the leaves are removed, hastening the opening of the bolls. By removing the leaves, boll rot caused by excessive leafiness and dampness is prevented on many bolls. With defoliation, bolls open rapidly affording a higher percentage of the crop to be harvested at the first picking. Often only one picking is necessary. Where machines are used, only dry leaf and bract trash are collected with the cotton.

Louisiana research, as reported to a Louisiana Agricultural Extension task force on cotton production practices [Rose, Baker, et al. (59)], indicated that defoliation was a questionable practice under many conditions. Often farmers defoliate too early and actually reduce their yield, more than offsetting the benefits gained from defoliation.

A report of the Cotton Defoliation Conference (22) summarized the benefits of defoliation as follows: (1) Earliness in boll opening. (2) Increased speed of hand picking, which is particularly true where cotton grows very dense and rank. Work in defoliated fields is more pleasant to the pickers and, because of more dew-free hours in the day and more cotton often being open at one time, the amount of cotton harvested by a hand picker in one day is usually higher. (3) Defoliation has a direct effect on insect control. Boll weevils are noted to leave defoliated fields almost immediately, and damage to open cotton by heavy aphid populations or late leafworm infestations may be prevented. (4) Defoliation is an effective means of control of the boll rot disease of cotton which causes great losses in wet seasons. (5) Seed from defoliated plots were found lower in moisture and free of fatty acid content than seed from non-defoliated plots. Defoliation at the appropriate time improved seed germination by as much as 20 per cent.

Defoliation becomes almost a necessity in the case of cotton to be harvested mechanically.

Brown and Woodall reported that Arkansas research (16) indicated that defoliation likely would be profitable under the following conditions: (1) When harvesting is to be done mechanically. However, if plants are short with few leaves present, and the leaves are leathery rather than tender, defoliation may not be necessary for successful mechanical harvesting. (2) When plants are tall, leafy, and succulent. (3) When fruit set is heavy. (4) When plants have 'cut-out' but not completely inactive. (5) When second growth is not excessive.

Brown and Woodall (16) said that Arkansas findings indicated that defoliation may not be profitable under the following conditions: (1) When plants are small. (2) When a large number of immature bolls and leaves are present. (3) When a large percentage of the leaves have fallen due to natural causes. (4) When boll set is light. (5) When leaves are inactive or toughened by drought. (6) When a killing frost is imminent.

There are many factors, stated Brown and Woodall (16) that may determine the profit or loss from the use of harvest-aid chemicals. An evaluation of the potential benefits and the requirements necessary to obtain good defoliation, together with a review of the conditions that favor good and poor defoliation, will aid the farmer in answering the question, "Is defoliation profitable?"

Proper timing is the key to successful defoliation, according to Moore and Thomas (46). Approximately 60 per cent of the bolls should be open when defoliants are applied. Defoliants will injure those bolls which are less than 35 to 40 days of age.

Bottom defoliation in Louisiana has not proven to be an economical practice, reported Baker (4). A wide variation of results has been obtained because of the widely varying weather conditions which prevail in the Mississippi valley. Application may be made from the air or on the ground. Defoliants are sprayed commonly from the air at rates of 3 to 10 gallons per acre. Most experiment stations recommend 5 to 10 gallons. One of the more commonly used materials for defoliant dusts is calcium cyanamid. This material contains about 57 per cent of calcium cyanamid. The recommended rate will vary from 25 to 40 pounds per acre. Another dust which is commonly used is sodium chlorate. About 50 per cent of this is active ingredients. Suggested rates are from 25 to 30 pounds per acre. Sodium chlorate which contains approximately 18.5 per cent active ingredients may be used as a spray. Magnesium chlorate and organic phosphorus compounds are also used. The organic phosphorus compounds are more efficient and dependable.

Tharp (72) said that the desiccants used are pentachlorophenol and arsenic acid. Desiccants are usually only recommended when the plants are so inactive that they do not respond properly to defoliants, or when the plants exhibit a large amount of second growth of leaves.

Rose, Baker, et al. (59), reported that harvesting is the most costly phase of cotton production. The two methods are hand harvesting and mechanical harvesting. Cotton has been harvested by hand since the beginning of its culture.

Andrews (1) reported that there are two means of harvesting by hand. One is known as picking, in which the seed cotton only is picked carefully from every bur and is as free as possible of leaves, bract, and trash. In the other, referred to as snapping, the open bolls are collected from the plants as a whole, burs, seed cotton and all, and cleaned out afterward.

In the Mississippi valley, reported Rose, Baker, et al. (59), 90 per cent or more of hand-harvested cotton is picked rather than snapped. Cotton producers normally allow snapping only in extremely wet falls when cotton is in the field in December and January.

Hand harvesting may begin as soon as a few bolls are open. Normally, in the Mississippi valley, there are first and second pickings, and then what is referred to as a scrapping. The availability of good hand pickers has been declining since World War II, but ginning facilities for cleaning, drying, and storing cotton have improved constantly.

The percentage of mechanical harvesting has steadily increased since World War II. Mechanical harvesters include the stripper type and the spindle type. The spindle type is used in Louisiana. International Harvester, John Deere, Allis-Chalmers, and Rust are the spindle-type pickers that are extensively used in the Mississippi valley. Mechanical harvesting ranges in cost from 15 to 20 dollars per bale, compared with approximately 50 dollars per bale for hand harvesting, reported Woolf (77).

Smilie, Thomas, and Standifer (64) found that when operated under the conditions for which it is adapted, the spindle-type cotton picker is a much cheaper method of harvesting than hand picking. Its superiority is increased when the machine-picked cotton is ginned on gins equipped with excess moisture removing driers, seed cotton and lint cleaning equipment.

Christidis and Harrison (18) reported that suitable varieties with plants maturing most of their bolls at approximately the same time, proper cultural methods, care in the operation of the picker, etc., are additional factors for a further increase in efficiency of defoliation.

Handling and Ginning

Until near the end of the Eighteenth Century and the beginning of the machine age, cotton lint quite generally was separated from the seed by hand. This process involved a great deal more labor than the hand-picking process. Brown and Ware (14) reported that the smaller gin used in India many centuries ago was the first gin on record. This ginning principle worked most efficiently with the smooth-seeded or sparsely fuzzy types of cotton like Sea Island, Egyptian, or most of the Indian and Chinese varieties.

According to The Fabric of Civilization (31), the great break-through in ginning came in 1792 when Eli Whitney, a New Englander, while visiting in the South, developed the first hook or spiked type gin. In May, 1793, Whitney returned to New England where he secured better tools and materials to complete his machine. On June 20, 1793, he applied for a patent, which was granted to him on March 14, 1794. In May, 1796, two years after Whitney obtained his patent, Hodgen Holmes of Augusta, Georgia obtained a patent on an improved gin. Holmes' improvement over Whitney's gin consisted of the substitution of circular saws for the rows of hooks and flat iron strips for the slotted bar. Before the Civil War, a gin house with a screw press for baling cotton was a familiar sight on every large plantation in the South.

The modern saw-gin of today exhibits great contrast to the original plantation gin. A quarter of a million dollars must now be invested in a complete modern ginning system, which includes usually at least two tower driers, two or three lint cleaners, one seed cotton cleaner, a stick and bur machine, and other special equipment. These high-capacity gins can turn out 12 to 15 bales per hour, reported Covey and Hudson (24). Many complaints have been voiced by mills that gins now over-dry and over-machine the cotton fiber, thus reducing the quality and staple length. With the present methods of harvesting, this type of ginning is necessary.

Changes in ginning have been as revolutionary as the changes in cotton production, which include mechanical harvesting and chemical weed and insect control.

Covey and Hudson (24) reported that selection of a gin by comparison of services is a common approach by producers. Many farmers select ginners of integrity and good reputation within a reasonable hauling distance and compare their services. Every farmer will find it to his advantage to become acquainted with all the conditioning and other special ginning equipment which is available in the gin.

Quality, Marketing, and Utilization

For many years the two primary factors to determine cotton quality have been grade and staple length.

Staple length of the fiber is very important to the spinner. Long fiber is needed in making fine yarns. As a rule, longer fiber will also be stronger and finer. The lengths of American Upland cotton, said Cardozier (17), are usually classified as follows:

Short staple	Less than 1 inch long
Medium staple	1 to 1-3/32 inches long
Long staple	1-1/8 to 1-11/32 inches long

Strength determinations, stated Hudson and Aguillard (36), are now made with the use of such instruments as the Pressley strength tester. Strength of Upland cotton ranges from 60,000 pounds to about 110,000 pounds per square inch, and is generally rated in the following manner:

Above 95	Very strong
86-95	Strong
76-85	Average
66-75	Fair
65 and below	Weak

Fineness, reported Hudson and Aguillard (36), is another common value which is utilized in fiber evaluation. This test is generally called the Micronaire, and it ranges as follows:

Below 3.0	Very fine
3.0 - 3.9	Fine
4.0 - 4.9	Average
5.0 - 5.9	Coarse
6.0 and above	Very coarse

Other measurements are being more commonly used by the trade. Even though cotton quality may still be a somewhat vague term, great strides have been made toward more accurately identifying cotton quality.

Generally speaking, the methods of cotton marketing have changed little in the last 100 years. Less progress has probably been made in cotton marketing than in cotton production. Some of the methods used prior to the Civil War are still in use today.

Cardozier (17) reported that by the time cotton is ginned and ready for market, some 7 or 8 months have been spent in its production. A lot of hard work, management, and money have been spent in growing and harvesting the cotton. Yet the efforts of 7 or 8 months can largely be erased if thorough study and intelligent thought are not given to the consideration of marketing.

The Government Loan Program, which was begun in 1933, has greatly assisted farmers in their marketing. The Smith-Doxie Classing Service has also been an important contribution to our marketing system.

According to Andrews (1), cotton is most frequently thought of in terms of the "fluffy white fiber that is the world's most important textile material." Not wo well remember is the fact that the cotton plant yields a greater quantity of human food and animal feed than it does of the fiber that bears its name. With each 100 pounds of lint, the cotton plant yields about 175 pounds of cottonseed. Only about 10 per cent of this quantity of seed is needed to plant the following year's crop. The remainder provides the basis for the cottonseed processing industry and furnishes the cotton producer with 10 to 15 per cent of his total income from the cotton crop.

Brown and Ware (14) divided the commercial products of cottonseed into four divisions: oil, cake and meal, hulls, and linters. The oil is the most valuable of the four products listed. It normally accounts for 50 to 55 per cent of the total value of the four. Cottonseed oil is primarily a food product and nearly all of its sub-products, when refined, enter into foods. The second most valuable product of cottonseed is cake or meal, which is used almost entirely as a feed for livestock. It is known as a protein concentrate. Hulls are the least valuable of the four main products obtained from cottonseed. Like meal, they are used primarily in the feeding of livestock, but as a carbohydrate ruffage. Linters have a wider variety of uses than any other cottonseed product. It is used in the production of felts, batting, mattresses, upholstery for furniture and automobiles, and many other uses.

Andrews (1) stated, "the final payoff in the long series of cotton growing, marketing, and processing steps comes when the ultimate consumer wears the cotton as clothing, sleeps on cotton sheets," or rides on automobile tires made of cotton cord. He said, "It is only after the fibers have been cleaned, carded, twisted together and intercrossed, and otherwise manipulated and treated that they take on the form in which they serve the needs of mankind."

An increase in cotton utilization must be obtained if cotton is to hold its own with man-made fibers. Andrews (1) stated that today this is the most crucial problem facing the entire cotton industry. Many of cotton's traditional markets are being eliminated each day by substitutes. "The potential market for cotton is increasing constantly because of the growth in the population. Consumption, however, varies considerably from year to year with business conditions and is being affected more and more by competition with synthetic fibers and paper." If cotton is to maintain its traditional share of the market, increased efforts in utilization research will be necessary.

ANALYSIS OF FACTORS AFFECTING PRODUCTION OF COTTON

Modern cotton production had its beginning in the 1930's. First came greatly improved varieties produced by hybridization. Then came mechanization with the use of the row-crop tractor and mechanical and other flame cultivators. During and immediately after World War II, the use of fertilizers increased greatly. After World War II, a wider selection of more efficient insecticides was available. Since 1950, the increased use of mechanical harvesting and chemical weed control has been well developed. More efficient quality evaluation has had increasing attention in the early 1960's.

These factors have contributed to increasing cotton yields, improving quality, and decreasing the cost of production. A detailed analysis of how different factors have affected cotton production from the 1930's to the present and what the future results may be is given in this section.

Information was obtained by review of literature on cotton, by participation on the Louisiana Agricultural Extension Task Force Study Committee On Cotton Production Practices, and by personal observation as Extension Cotton Specialist.

Varieties

Since 1930, cotton varieties grown in Louisiana have decreased in number and in variation among varieties. Prior to this time, cotton varying from the Sea Island (1-1/2 inch) type to the Half and Half (3/4 inch) type was being grown. At one time there were over 200 different varieties being used in Louisiana. Half and Half, which was a high-yielder and had high lint per cent, was very short in staple. Before the early 1930's no one had been able to combine length, high yield, and high lint per cent. The Delta and Pine Land Company accomplished this through a hybrid cross, and the other cotton breeders followed suit shortly thereafter. Varieties have gradually become more similar. There are still characteristic varietal differences, but the differences are much smaller today than in the past.

Very recently, however, a number of varieties have appeared on the market which possess special characteristics. During the past few years many cotton producers have become very interested in early maturing varieties because of weather conditions. There are advantages and disadvantages to these early varieties. There are several practices which affect earliness besides the inherent characteristics of the variety. Among them are:

1. Rate of fertilization. Researchers in Mississippi placed 120 pounds of nitrogen under a group of early maturing varieties

and 60 pounds of nitrogen under a group of late maturing varieties. The late maturing varieties with 60 pounds of nitrogen were harvested first, showing that fertilizer affects maturity as much or more than does variety.

2. Date of planting. About 150 days are required for the boll to mature on any variety.

3. Insect programs. There are some indications that some insecticides delay maturity.

For early cotton, a producer should choose an early maturing variety, fertilize with nitrogen lightly, plant as early as possible, and practice an insect control program that will not delay maturity. It takes an above-average farmer to carry out these practices and not sacrifice some yield.

In a modern mechanized cotton operation 20 to 30 per cent of the total acreage could be placed in an early-maturity program in order to spread the harvest date and to average out weather damage.

If a severe wilt problem exists, the producer may want to consider a wilt-resistant variety. The following varieties possess some resistance to fusarium wilt; however, if a fusarium wilt root-knot complex is a problem, these do not possess sufficient resistance. They are Coker 100A, Empire, Dixie Queen, Carolina Queen, Rex, and Auburn M. Soil fumigation can be used in conjunction with these varieties or may be used alone.

To date there are no true hybrids available to the cotton farmer. There is a varietal mix available which is produced under high cross-fertilization conditions. This mix has some hybrid vigor, but is not a true hybrid, according to Baker (6). Hybrids may come in the future.

Baker (6) presented the following brief descriptions of varieties presently being grown in Louisiana:

> Deltapine 15 was developed by the Delta and Pine Land Company of Scott, Mississippi. This variety has been grown extensively throughout the South, although in recent years the larger acreage has been in Mississippi and adjoining states. It arose from a complicated series of Upland hybrids produced by Early Ewing of the Deltapine Company. It is very susceptible to fusarium wilt and root-knot, but moderately tolerant to verticillium wilt, and has high lint per cent. It is moderately susceptible to bacterial blight.
>
> Deltapine Smooth Leaf was developed and distributed by the Delta and Pine Land Company, Scott, Mississippi. It is a selection out of Deltapine 15 which has less pubescence and was released in 1957. Deltapine Smooth Leaf is rapidly replacing Deltapine 15 on the farms in Louisiana. A selection from a smooth line of Deltapine was made in order to obtain a better grade of machine-picked cotton. It is similar to Deltapine 15, but has been slightly more productive and earlier on some soils. One chief objection is its susceptibility to fusarium wilt.
>
> Fox-4 is an early maturing variety in the Mississippi valley. It was derived by selection from Deltapine Fox which in turn originated from a cross of Deltapine 14 and Stoneville 2B. It has improved spinning quality of fiber and has more tolerance to fusarium and verticillium wilt than Fox. The chief objection is lack of storm-resistance.
>
> The Deltapine 45 variety has just been released for the 1964 growing season. It was developed by the Delta and Pine Land Company of Scott, Mississippi as a selection from Fox-4. It possesses more tolerance to both verticillium and fusarium wilt than any other Delta and Pine Land variety, and, in addition, it is an early-maturing variety.

Stoneville 7A was developed and distributed by the Stoneville Pedigreed Seed Company, Stoneville, Mississippi, and was released in 1962. This variety moderately resists verticillium wilt. It was developed from Stoneville 7. It is a high lint per cent variety and has improved fiber quality over Stoneville 7.

Stoneville 213, developed from a selection of Stoneville 7 and distributed by the Stoneville Pedigreed Seed Company of Stoneville, Mississippi in 1962, was selected for earliness and slightly stronger fiber and has the same moderate verticillium wilt-resistance as Stoneville 7.

Stoneville 3202 was developed and distributed by the Stoneville Pedigreed Seed Company, Stoneville, Mississippi. It is an early maturing variety, selected out of Stoneville 5.

Delfos 9169 was developed and distributed by the Stoneville Pedigreed Seed Company, Stoneville, Mississippi. Presumably, it was developed from a natural cross between Stoneville 2B and the old Delfos varieties. This variety fruits slowly and is late maturing; bolls are larger than Deltapine 15. Gin turnout equals that of Fox but is less than that of Deltapine 15.

Rex was developed and distributed by the Arkansas Agricultural Experiment Station, Cotton Branch Station, Marianna, Arkansas and released to growers in 1958. It is an early-maturing variety of the Empire type and has resistance to bacterial blight and fusarium wilt. It is a short plant type, close fruiting cotton with medium to large bolls. It is also tolerant to verticillium wilt. Its chief objection is low fiber strength and its tendency to lodge.

Rex Smooth Leaf was developed by the Arkansas Agricultural Experiment Station and was released in 1963. The smooth leaf factor was transferred from an okra leaf to Rex through a series of crosses and backcrosses. It is similar to Rex other than the smooth leaf character.

Stardel was developed and distributed by the Department of Agronomy, Louisiana State University, Baton Rouge, Louisiana. It was selected from a cross between a strain of Stoneville and a strain of Deltapine 14, and was commercially released in 1955. This variety has the highest yarn strength of any medium staple variety grown commercially in the Mississippi valley. It is a medium maturing variety with small boll, and above-average gin turnout. Its chief objection is its susceptibility to verticillium and fusarium wilt.

Coker 100A was developed by the Coker Pedigreed Seed Company, Hartsville, South Carolina and distributed to growers in 1957. This is a later name for Coker 100 WR which was developed from a cross of Coker 100 by Clevewilt. It is resistant to fusarium wilt when there are no root-knot nematodes present. It tends to lodge under conditions conducive to excessive vegetative growth.

Carolina Queen is a new variety developed by Coker Pedigreed Seed Company and was released to growers in 1963. It is a selection from a cross of Coker 100 Wilt and Empire. It is resistant to fusarium wilt and slightly more determinate than Coker 100A. It also has a higher lint per cent than Coker 100A.

Auburn 56 was developed at the Alabama Experiment Station by selections from a cross of Coker 100 with Cook 307, backcrossed to Coker 100 WR. It is one of our most highly tolerant varieties to root-knot nematodes and fusarium wilt. Boll size may be classified as medium. Fiber is average in strength. Lint per cent is lower than Deltapine 15 but this is more than compensated for by seed cotton yield when the wilt nematode complexes are a problem. Its chief objection is a tendency to lodge under rank growing conditions.

Dixie King was developed and distributed by Bobshaw Pedigreed Seed Company, Indianola, Mississippi. It is similar in appearance to Empire and presumably is a selection from a three-way cross involving Empire, Coker 100, and Bobshaw 1A varieties. This big-boll variety is resistant to fusarium wilt and tolerant to verticillium wilt. Its chief objections are it tends to grow rank on high fertility soil and the stalk tends to be weak.

Empire WR, developed by the Georgia Agricultural Experiment Station, Experiment, Georgia and released to growers in 1944. It is a larger boll variety which was selected from

Stoneville 2 and probably was a natural hybrid of Stoneville 2 and Clevewilt. The current variety is Empire WR 61 which is a selection out of Empire WR.

DeKalb 108 was developed and distributed by the DeKalb Agricultural Association, Inc., Athens, Georgia. It is a mix of unknown varieties grown under high crossing conditions. The majority of the varieties are probably eastern type such as Empire, Coker, Auburn, Plains, etc. It has been a high yielder in some states and is about average or above in most tests in Louisiana.

DeKalb 220 was developed and distributed by the DeKalb Agricultural Association, Inc., Athens, Georgia, and was a mix of unknown varieties grown under conditions conducive to high crossing. The majority of the varieties are probably Delta type, such as Fox, Stoneville, Deltapine Smooth Leaf, Dixie King, etc. It has not been tested extensively in Louisiana.

The four-year average of eleven of the above-described varieties grown at Alexandria, Bossier City, and St. Joseph in the years 1960 through 1963 are shown in Table II. Top yielding varieties for the four-year average at the above three locations were: Stoneville 7A, Stoneville 213, Stardel, and Deltapine Smooth Leaf. As can be noted, there is no one best variety for a particular area. At present, 70 per cent of the Louisiana cotton acreage is planted in Deltapine varieties. However, this percentage has been declining in recent years.

Delinted treated seed with high germination should always be planted, preferably seed with a germination of above 80 per cent when available. Seed should not be more than two years from the breeder's stock (second-year certified, red tag). Research from the Mississippi Experiment Station showed a definite decrease in yield

TABLE II

FOUR-YEAR AVERAGE OF ELEVEN COTTON VARIETIES GROWN AT ALEXANDRIA, BOSSIER CITY, AND ST. JOSEPH, LOUISIANA (56) FROM 1960 THROUGH 1963

Variety	Yield: Pounds of lint per acre			4-year average three Locations
	Alexandria	Bossier City	St. Joseph	
Stoneville 7A	1304	876	1238*	1139*
Stoneville 213	1231	773	1302*	1102*
Stardel	1223	798	1261	1094
Deltapine Smooth Leaf	1188	765	1285	1079
Fox-4	1175	811	1203	1063
Auburn 56	1187	764	1213	1055
Stoneville 3202	1213	706	1241	1053
Delfos 9169	1203	790	1111	1035
Dixie King	1163	691	1131	995
Coker 100A-WR	1078	697	1086	953
Rex	1097*	758	991*	949

* Three-year average at St. Joseph.

after the second year certified.

According to Baker (7), the development of the cotton plant falls within the following time limits. The information applies only to cotton crops which are developing normally and are not beset by outside influences such as insects, diseases, drought, or nutrient deficiencies. Varying climatic conditions and variety differences under which cotton is grown in Louisiana account for the upper and lower time limits.

	Number of Days		
	Average	Low	High
From planting to emergence	7	4	10
From emergence to square	32	27	38
From square to white bloom	23	20	25
From white bloom to open boll	55	45	66
June blooms		45	55
July blooms		55	66
(Rich soil 4 to 5 days later than thin soils)			
From bloom to full grown boll	21	20	25
Average number of days from planting to peak blooming	90		
Critical period after blooming which determines fiber length (Available soil moisture during this period is the limiting factor in determining length of lint in a given variety)		13	20

	Number of Days		
	Average	Low	High
Strength of fiber determined after maximum length is reached (16-18 days after blooming)	30	25	40
Time required to produce normal crop	150	130	170
Time from first white bloom until 60 per cent of crop is open	85	75	95

The next big break-through in cotton breeding may be the production of a true cotton hybrid. This very well may occur within the next 5 to 20 years. Hybrids would increase production from 15 to 20 per cent. In the meantime, improvements will be made in disease resistance, fiber quality, and adaptation to mechanization, etc. Varieties alone will not solve a cotton farmer's problems, but they offer him another tool to use in meeting them.

Climate and Moisture Requirements

Cotton production in Louisiana and other Delta states is affected as much or more by weather variability than in any other cotton producing area. Variability in the growth and production of cotton is influenced greatly by temperature, moisture, and light. Temperature affects both cotton seed germination and seedling growth.

Soil temperature continues to exert an important influence on the growth and development of the cotton plant throughout the season. Because the plant soon develops its root system to depths at which temperature rises or falls only gradually through the summer, the grower's main concern with temperature relates to the air temperatures that occur when the plants are well past the seedling stage of development.

When the soil is dry, the soil and mean temperatures will be about the same. Wet soil temperature is usually 3 to 5 degrees lower than the mean temperature. In Louisiana, fall temperatures greatly affect yield, early frosts and early freezes.

One of the most damaging factors in Louisiana cotton production is an excess of water during harvest season. This occurred in 1957 and 1958, reducing yields drastically and hampering mechanical harvesting. This is one of the primary reasons that producers in Louisiana have become vitally interested in early-maturing varieties.

Sunlight is another major weather factor. Cotton produces best if the weather is relatively cloudless during the greater part of its period of active growth.

What can the producers do about weather? Utilize the law of probability! He should know the chance or probability of temperature, rainfall, and other weather conditions in his locality during critical periods. He should practice land management, drainage, and land leveling. He should consider supplemental irrigation.

Soil Preparation, Seeding, Fertilization, and Cultivation

A cotton production program is greatly influenced by soil preparation. Soil preparation includes complete destruction of residue from the past season's crop, seedbed preparation, drainage, elimination of hard-pans, and destruction of weed populations.

Research has shown that excessive and destructive tillage impairs the ability of plants to use moisture and nutrients most efficiently and tends to increase production costs. In some areas of Louisiana it is not unusual for eight or more preplanting operations to be used. The purpose of most of these trips over a field is for surface refinement. However, rains and prolific weed growth are factors that often encourage excessive tillage.

Good soil preparation will have a favorable influence on all phases of production, from planting through harvesting. With the rapid increase in precision planting, precision application of herbicides for weed control, high-speed multiple row-cultivation, supplemental irrigation, and mechanical harvesting, greater emphasis is being placed on soil preparation.

Today, in Louisiana, several different tillage systems are used, depending on soil type, soil density, soil moisture conditions, residue situation, and equipment available. A typical system for preparing land for cotton consists of cutting the old stalks immediately after harvest, disking at least once in the fall, subsoiling if applicable, disking again in early spring, bedding, applying fertilizer, hipping, and pulverizing the seedbed immediately before planting. The total of these operations will usually range from 8 to 15 dollars or more per acre.

In addition, some farmers disk prior to hipping in an effort to refine the seedbed and eliminate weeds on the top of the beds. Findings at the Delta Branch Experiment Station, reported Rose and Baker, (59), indicate that soil preparations can be overdone on light or sandy soils. This over-preparation can involve not only the expenditure of excessive time and money but may be detrimental to the soil or to the crop. The Macon Ridge Experiment Station is in agreement with the Mississippi Delta Experiment Station that light or sandy soils should not be disturbed until late winter or early spring.

Buckshot soils, Sharkey clay, are extremely difficult to prepare for cotton planting in the spring, according to Rose, Baker, *et al.* (59). Preparation of these soils should be done in the fall or early winter. Good drainage is essential. Nitrogen, as anhydrous ammonia or ammonium nitrate, can be applied in the winter or early spring with efficiency comparable to any other time of application.

Land-forming values are tremendous. Louisiana has always been concerned with drainage, and much of the land requires artificial drainage to make it fit for cultivation. The average rainfall is over 50 inches annually and it is necessary to move this water off with the least possible crop and soil damage.

Potholes are also a problem in many fields. Working the whole field is often delayed by conditions prevailing in a small portion of the field. Row direction, slope, and drainage are all important.

Land forming and land leveling for drainage as well as irrigation have been proven desirable and economic practices by the Experiment Stations in both Mississippi and Arkansas. The feasibility of these practices is determined by the type of soil and the managerial ability of the operator.

Baker (8) said that, at planting time, every step should be taken to place the seed under the best conditions for germination and subsequent development. The first step is the use of good cotton seed. One of the best ways to insure good planting seed is to select an adapted recommended variety and buy seed which are "blue tag" or "red tag " (first year or second year certified), which have been delinted, and which have a known germination of at least 80 per cent.

Time of seeding or optimum planting dates have been worked out by the Experiment Stations for the areas concerned. In general, the dates for the State of Louisiana are April 22 through May 5.

Northeast Louisiana shows a probability that the 2-inch soil temperature will average 68° F. for 10 days after planting, three years in four, on April 21. Farmers, reported Rose, Baker, et al. (59), have a habit of gambling on these dates. Most of them desire an early crop, and if the weather looks good they try to push the planting date up. It is more important now than ever before, with the use of chemicals, that farmers be encouraged not to plant too early but to wait until the recommended date for their areas.

The next problem involved in seeding is spacing. If a pre-emergence weed control chemical is to be applied, the soil near the plants must not be disturbed. Hence, it is advantageous to either hill-drop or drill to a stand.

Research work, according to Rose, Baker, et al. (59), showed that hoe labor was reduced 25 per cent by hill-dropping and pre-emerging. Where no chemicals were used, hoe labor was cut 32 per cent by hill-dropping over drilling. On the basis of this information, hill-dropping might save Louisiana farmers over one million dollars per year.

Mechanical harvesting also calls for special conditions in spacing and plant population. In general, it has been found that there is no significant difference in yields between the plant populations of 13,000 plants per acre and 65,000 plants per acre. This is a wide range compared to other crops. However, in order to obtain uniform pressure on the picker drums of mechanical harvesters, a plant population of 35,000 to 45,000 per acre is generally considered ideal.

The seeding rate will vary from 30 to 60 pounds for cross-plowing or mechanical chopping. When chemical weed control is to be used, an approximate rate of 14 to 21 pounds of mechanically delinted seed are generally used. The seed are hill-dropped or planted to a stand. Acid delinted seed range from 9 pounds to 15 pounds per acre under the same conditions.

As far as nutrients are concerned the cotton plant is not hard on the soil. Its nutrient requirements are slightly less than those of corn and tobacco, and considerably less than those of peanuts or alfalfa.

For each bale of cotton produced, the plants use about 75 pounds of nitrogen, 35 pounds of P_2O_5 and 60 pounds of potash. More than these amounts must be present in order for the plant to absorb the required amounts. When stalks are turned back, the seed and lint in one bale of cotton remove approximately 35 pounds of nitrogen, 15 to 20 pounds of available phosphoric acid, and 15 pounds of potash.

Cotton also removes considerable quantities of calcium, smaller amounts of magnesium, sulfur, and sodium, and minute quantities of boron, iron, manganese, zinc, copper, and chlorine.

During the seedling phase of its development the cotton plant needs comparatively high quantities of nitrogen, phosphorus, potash, calcium, and magnesium. As the plant enters the squaring phase of development, its demand for nutrients increases rapidly along with its size and tissue-manufacturing ability. Of the crop's total seasonal requirements for the five main plant nutrients, nitrogen, phosphorus, potassium, calcium, and magnesium, it accumulates about 1 per cent in the first 30 days of growth and about 3.5 per cent by the end of 45 days. During each of the next three 2-week periods, it accumulates 6 to 8 per cent of the total that it will absorb. The greatest nutrient uptake occurs during the heaviest fruiting period. This is the period between peak blooming and first open boll.

When there is a deficiency of nitrogen, the cotton plants become stunted and woody. The leaves turn yellow-green and then yellow and are shed. Excessive available nitrogen increases vegetative development and causes rank growth.

When available phosphorus is low, development of both roots and tops is inhibited, plants are stunted, and leaves sometimes develop a very dark green color.

Getting the right rate, kind, and amount of nutrients to the cotton plants is a major problem. Fertilizer is one of the important variable factors that can help determine net profits. The best method for

Louisiana farmers is to determine fertilizer needs through soil testing. No two fields are exactly alike. Each area should be tested individually. This will help the producer to make economical use of needed nutrients.

If a quick growth response is desired, anhydrous ammonia may be sidedressed in the edge of the root zone. If nitrogen is applied for the first time after the cotton is chopped, it should be placed 6 to 8 inches to the side of the row and 6 inches deep.

Cotton rotation is an important step in a land-management program. It helps maintain and increase soil productivity. Advantages of a good crop rotation are: (1) it insures against total crop loss in any one year; (2) it utilizes farm labor more efficiently; (3) it replentishes organic matter and, where legumes are used, supplies additional nitrogen; (4) it reduces erosion; (5) it increases utilization of native soil fertility; (6) it reduces plant diseases, insects, and weeds; (7) it improves physical condition of the soil; and, (8) it makes fertilizer and lime more effective.

Thus far deficiency symptoms of the other minor elements, iron, copper, zinc, and molybdenum have not been observed in Louisiana. However, molybdenum is being added to certain soils on which soybeans are grown in the central and upper Mississippi valley, particularly in Arkansas.

Fertilizer can be applied at planting time in narrow bands approximately 2.5 inches from the seed row and 2.5 inches below the level of the seed. Anhydrous ammonia should be placed 6 to 8 inches below the seed. Additional nitrogen may be added during the growing season.

The Northeast Louisiana Experiment Station, Saint Joseph, Louisiana, rotated cotton with corn alone, with corn and soybeans interplanted, and with corn and soybeans on alternate double rows. The 3-year average of cotton produced following corn and soybeans interplanted and corn and soybeans on alternate double rows showed an increase of 600 pounds of seed cotton. By improving the physical structure of the soil through rotation, the economic savings to the cotton producer was in the form of the absence of plow-soles or hard-pans and smaller amounts of fertilizer needed.

Some research workers in Louisiana, Arkansas, and Mississippi have reported that winter legumes are of little value in increasing soil productivity except for the nitrogen added, and that this nitrogen could be bought cheaper commercially than it can be produced by growing winter legumes.

During the past 10 years the acreage planted to winter legumes has gradually diminished in some parishes of Louisiana, from about 50 per cent of the cotton land to about 2.5 per cent in these same parishes. It is this investigator's belief that in many areas winter legumes have a definite place in the cotton production program.

The primary purpose of cultivation after emergence of cotton is for weed control. However, the purpose of cultivation has been the subject of some controversy. Many farmers have the popular conception that cultivation gives the soil particles a structure compatible with good germination and growth. Many feel that cultivation also conserves soil moisture and on some soils this is true.

Cultivation can result in root pruning and moisture loss, and it tends to increase production costs. Precision cultivation is needed in depth control, soil movement, and to avoid plant injury.

Weed Control

Weeds have been defined as plants growing in places where they are not wanted. Weeds rank among the major pests in cotton production, both from the standpoint of their adverse effects on yield and quality and the cost of control. Despite technological advances over the years, weed control costs still amount to nearly 20 dollars per acre, or the equivalent of about 4 cents per pound of lint for Louisiana as a whole. From before the Civil War period to 1940, major advances made in weed control were through cultural practices, stimulated by improvement of implement designs with their adaptations to high speed and multi-operation power equipment.

Many methods of weed control are employed by cotton farmers of Louisiana. They include rotation, mechanical cultivation, hoeing, geese, flame cultivation, and, at present and probably the most important, chemical weed control.

Development of 2,4-D (2,4-dichlorophenoxyacetic acid) in the middle 1940's gave great impetus to a new era of selective herbicides. Even though this compound could not be used on cotton because of cotton's high sensitivity, it did motivate development of selective herbicides which have been used to varying degrees of success with cotton. In the last ten years, well over 100 new herbicides have been introduced, a few of which have been satisfactory for use in cotton fields.

Weeds deprive cotton of nutrients, water, and light. Emergence and stand are also adversely affected by weeds. There have been indications that weeds produce toxic chemicals which are released into the soil surrounding the seeds of the crop, thereby prohibiting germination and affecting stands. Weeds obstruct the mechanical operation of cultivation and mechanical harvesting. They are hosts of a number of detrimental disease organisms and insects. Weeds also adversely affect cotton quality. Some of the most troublesome weeds commonly found in cotton fields in Louisiana are: Johnson grass, cockleburr, crabgrass, morning glory, nutsedge or nutgrass, and pig weed. In

Louisiana weeds are generally a greater problem during the early and late parts of the growing season. Rotation is one of the most effective and cheapest methods of weed control; however, most Louisiana cotton farmers have been reluctant to rotate cotton land with other crops. This is primarily due to cotton being grown on the most productive soils on the farm, and the producer is reluctant to shift cotton production to the less fertile soils. For this reason the benefits of rotation are greater as a soil improvement practice than as a weed control practice.

Mechanical cultivation with sweeps and ground-driven rotary hoes has been used for some time and needs little explanation. Care should be taken to avoid deep cultivation which will prune the roots of the cotton plants. Even shallow cultivation should be used no more often than is necessary for weed control.

Cross-cultivation may be practiced where cotton is drilled at a heavy rate. The cotton is cultivated both with and at right angles to the row. Cross-cultivation thins the cotton and also weeds a large part of the drill area. Its use should be generally restricted to lighter soils and to relatively level fields. A stand of 6 to 8 stalks per hill is generally satisfactory. Second and later cross-cultivations will plow out additional plants, thus the first crossing must leave a few more plants than are needed for the final stand.

The rotary hoe is another mechanical tool which is used for controlling weeds and grasses in cotton. The rotary hoe not only breaks the surface crust about the young plants but also destroys many tiny weeds.

The use of hill-dropping or planting to a stand by a majority of the farmers has eliminated to a great degree the need for the thinning or chopping operation. Hand hoeing is still being used as a method of weed and grass control in Louisiana. Although the hoe has not been completely eliminated, its use has been drastically replaced by the substitution of mechanical, chemical, and flame weed controls. With the use of new chemicals and advanced technology, hand hoeing can be reduced to one flat-weeding.

Weed control by geese in Louisiana has given varied results. Where Johnson grass is the main weed, geese can substitute a large percentage of the hoeing. Geese are bought in the spring as goslings when they are about 10 weeks of age. It takes about 1.5 to 2 geese per acre to keep cotton clean. Geese do not eat the broad-leafed plants. There are several disadvantages to the use of geese in a cotton field. Certain insecticides, such as toxaphene, used on cotton will kill geese. There is also danger of loosing them from attacks by dogs. Geese are adapted to specific situations for weed control in cotton in Louisiana. They are particularly well adapted to the control of excessive Johnson grass infestations on farms with superior management.

Flame cultivation is another method of weed control which is used extensively in Louisiana, following pre-emergence and post-emergence chemical treatment. Flame treatments may be started when the cotton stems are at least 0.2 inch in diameter. The field should be free of large weeds. Flaming is much more effective on small succulent weeds than on large well established ones. After the first flaming it should be used often enough to prevent weeds from growing beyond the seedling stage. Cotton will require normally three to five flamings before cultivation is terminated.

Preparation for chemical weed control must begin well ahead of the crop season. The row should be firm and properly shaped, flat across the top, old crop residues should have been thoroughly pulverized and turned under, and all weeds destroyed before planting.

Chemical weed control is divided into three phases: pre-emergence, post-emergence and lay-by. Pre-emergence spray should be applied by means of a nozzle centered over the drill into the rear of the planter press wheel. A single 80-degree platform type nozzle should be used. The primary parts of a sprayer system used to apply herbicides are a power-take-off pump, connecting hoses, storage tank, pressure regulator, and nozzles. There are two generally recommended pre-emergence chemicals being used in Louisiana. The first and by far the most commonly used, is diuron [3-3, 4-dichlorophenyl)-1, 1-dimenthyl-urea]. This material is in a liquid suspension and requires constant agitation to maintain an even mix. Diuron contains 2.8 pounds of technical material per gallon. One-half pint is recommended on light textured soils while three-fourths of a pint is recommended on medium textured soils. Diuron controls most annual weeds for a period of 3 to 4 weeks provided sufficient moisture is available. If the soil becomes dry, herbicidal action will be greatly reduced. Diuron kills weeds only after they emerge from the soil. Diuron will kill cotton. The primary safety factor is the soil between the seed and the surface where the diuron is applied. In direct contact with the seed, the material will definitely cause harm.

CIPC [isopropyl N-(3-chlorophenyl)-carbamate] is the second pre-emergence herbicide recommended, but it is not commonly used by Louisiana cotton producers. Its performance is similar to that of diuron; however, the cost to the producer is approximately twice the cost of diuron.

There are three pre-emergence chemicals which are presently on trial recommendation and have shown promise in research plots at experimental stations in Louisiana. The first is trifluralin [2, 6-dinitro-NN-di-n-propyl-xxx-trifluoro-p-toluidine]. Trifluralin has shown promise of being an outstanding pre-emergence herbicide for cotton. It controls a wide range of annual broad leaf weeds and grasses, including seedling Johnson grass. There is some indication that trifluralin is superior to other available materials for dry soil conditions. It may control weeds for a longer period of time than other materials. Although incorporation of trifluralin into the soil has not consistently given more effective weed control in Louisiana, most research workers feel that it should be incorporated with the soil. Incorporation may be achieved more efficiently by power-take-off equipment. The double disk with spike tooth harrow in tandem run two directions, the bed conditioner, and other specially designed tools for chemical incorporation may also be used. Trifluralin is being used on a considerable acreage in Louisiana in 1964.

Prometryne [4, 6-bis(isopropylamino)-2-methylthio-(1, 3, 5-triazine] is another chemical which is being recommended on a trial basis, 1 to 3 pounds of prometryne 80W per acre is applied on light to medium textured soils. Prometryne gives results similar to that of diuron. It is somewhat more effective on broad leaf weeds than on grasses.

The third pre-emergence chemical recommended on a trial basis for cotton is norea, [3-(hexahydro-4, 7-methanoindan-5-yl)-1, 1-dimenthylurea]. One and one-half to 2.5 pounds of norea (80 per cent wettable powder) per acre is recommended on light to medium textured soils. Norea seems to be about as effective as diuron. There is some indication that cotton is more tolerant to norea than to diuron.

The only post-emergence chemical recommended in Louisiana at the present time is herbicidal oil applied at the rate of 5 gallons per acre on an 8- to 10-inch band or 7 gallons per acre on a 12- to 14-inch band. Cotton should be 2.5 to 3 inches tall at the time of spraying. Weeds will be killed by contact, so complete coverage is required. One or two applications of herbicidal oil are normally made in cotton production. When the stems of cotton plants begin to crack at the ground level, herbicidal oil application must cease for the oil will penetrate this lesion and injure or kill the cotton plant.

A trial recommendation for post-emergence weed control is diuron plus surfactant at the rate of 0.5 per cent surfactant and 1 pint of diuron per acre in a 25-gallon mixture.

Although broadcast application of weed control chemicals to cotton fields as a lay-by treatment has been practiced by many Louisiana cotton farmers during recent years, the economic advantages of lay-by treatments have been difficult to justify. Presently recommended on a trial basis is diuron wettable powder at rates of 0.5 pound for light textured soils, 1.0 pound for medium textured soils, and 1.5 pounds for heavy textured soils. This chemical should be applied when the cotton is 15 inches tall or taller.

Small scattered clumps of Johnson grass may be successfully controlled by spot treatment with dalapon, [2, 2-dichloropropionic acid]. Dalapon at the rate of 1.0 pound commercial formulation per 5 gallons of water should be applied so as to wet the leaves of 6- to 12-inch Johnson grass. Re-treatment some two to three weeks later will be necessary to eliminate those plants missed on the first application.

Chemicals for weed control in cotton will continue to increase in number and in efficiency. However, producers must be careful to read the label on each container. Use herbicides only on the crop suggested on the label and handle them with care at all times.

Diseases

Enormous crop losses are caused by cotton diseases in Louisiana. In the years 1959-61 Louisiana farmers are estimated to have lost 16.83 per cent of the total crop, or approximately 103,861 bales of cotton annually. Despite the heavy losses, many farmers still do not take the disease problem seriously. This is primarily due to their inability to recognize the diseases. Quite often the damage is incorrectly attributed to adverse weather, insects, lack of fertility, or some other cause.

Since cotton is a native of tropical and sub-tropical regions it is more susceptible to disease during cool damp weather. Cotton diseases are related to soil conditions, cultural practices, variety planted, and other factors. Fortunately, most cotton diseases can be controlled. Usually the cost of control is not high.

Major diseases which contribute to losses in Louisiana are: seedling diseases, fusarium wilt, verticillium wilt, root-knot, crinkle leaf, and boll rot.

Seedling diseases are caused by a complex of seed-borne and soil-inhabiting organisms, the most important one in Louisiana being Rhizoctonia sp. Of less importance are species of fusarium and pythium which also contribute to seedling disease. Because seedling diseases have so many different effects on the plant, it is difficult to give a complete description of the symptoms. In general, infected plants are pale, unhealthy, and slow-growing, with reddish brown lesions near or below the ground level.

One of the most effective controls for the seedling disease complex is the use of high-quality planting seed which have been treated with recommended disinfectants.

Research at the Northeast Louisiana Experiment Station and the Red River Valley Experiment Station has shown that sore-shin can be partially controlled by soil treatment. Certain fungicides are mixed with the soil that surrounds the seed at the time of planting. A mixture of 10 per cent PCNB, or terraclor [pentachloronitro-benzene] plus 10 per cent of either captan, maneb, zineb, or thygon is very effective in insuring stands. Application of these fungicides to the soil may be made by three methods; (1) the hopper box method, (2) the spray method, and (3) the dust method. The hopper box method is the easiest but the least effective of the three. Certain cultural practices will also reduce losses. These include planting on a firm, well-pulverized seedbed, delaying planting until the soil warms up, and liberal fertilization. It must be pointed out, however, that quality seed, seed treatment, and soil treatment cannot make up for adverse weather conditions or poor agronomic practices.

Fusarium wilt in Louisiana is quite often associated with root-knot nematodes. It has been estimated that fusarium wilt accounted for 3.67 per cent loss of the entire state crop in the years 1959-61. Wilt-infected plants are characteristically stunted, severely wilted, and fired, and have yellowish leaves. The plant stem at the ground line will show an internal browning of the stalk tissue. Fusarium wilt can be satisfactorily controlled by growing wilt-resistant varieties such as Auburn 56, Auburn M, Coker 100A, Empire WR, Rex, Dixie King, and Carolina Queen. Other control measures include application of a balanced fertilizer with sufficient potash, rotation and application of soil fumigants to reduce nematodes. When nematodes are present with fusarium wilt forming a complex, Auburn 56 has proven to be a superior variety.

Verticillium wilt, another disease which is caused by a soil-borne fungus, has done some damage in Louisiana. The disease is much less extensive than fusarium wilt. It has been estimated that the crop loss from verticillium wilt in the years 1959-61 was 0.73 per cent. In Louisiana verticillium wilt affects the cotton plant more in the mature stage. The outstanding symptom of the disease is development of chlorotic and brown areas on the leaves. The woody parts of the roots and stalk turn brown as the disease progresses through the entire plant. Verticillium is often confused with fusarium wilt. Tolerant or resistant varieties offer some degree of control. Shallow cultivation and balanced fertilization also assist.

A field examination for wilt may be made by cutting a cross-section of the stem and examining for the brownish ring formed inside the cambium. In Louisiana the most practical control of fusarium wilt is the planting of wilt-resistant varieties. In fields where the disease is severe, varieties such as Auburn 56, Coker 100A, and Empire have been the top performers. Other control measures are: (1) Rotate cotton with non-susceptible crops such as corn, sorghum, and small grains, and (2) control nematodes.

The root-knot and the reniform nematodes have been quite injurious to Louisiana cotton crops. The root-knot nematode not only is destructive to the plant, but causes wounds whereby the fusarium wilt fungus, *Fusarium vasinfectum*, may enter the plant. Probably the most economical way to control nematodes in cotton is the growing of a tolerant variety such as Auburn 56 which has been shown to be superior in Louisiana. Other practices are to rotate cotton with non-susceptible crops such as corn and sorghum and to use recommended soil fumigants. The root-knot nematode of cotton can be controlled by field fumigation of the soil with DBCP [1, 2-dibromo-3-chloropropane].

Another disease which has been identified in Louisiana is "crinkle leaf" or manganese toxicity. Crinkle leaf is associated with acid soils, calcium deficiency and excess manganese. The disease is readily controlled by an application of lime and the establishment of good drainage.

Boll-rot losses in Louisiana are greater than from any other cotton disease. They were estimated to be 6 per cent of the entire crop for 1959-61. In years with wet fall weather, as in 1957 and 1958, the percentage of loss is many times higher. Boll rot is caused by a number of different organisms. They may be divided into two groups: those organisms which can penetrate the uninjured boll, and those organisms which enter the wounds provided by insects, weather, and other diseases. Boll rot is most severe under conditions where cotton grows tall and rank. Some of the cultural practices which tend to reduce boll rot are: skip-row planting, improved drainage, moderate nitrogen fertilization, adequate insect and weed control, and avoiding mechanical injury of the bolls.

Insect Control

Cotton is subject to attack by insects from the seedling stage to complete maturity. Tremendous progress has been made since World War II in developing more effective control of cotton insects. Heavy fertilization and supplemental irrigation tend to stimulate plant growth and fruiting. This has extended the growing period later in the season. Cotton plants that are vigorous, rapidly growing, and rapidly fruiting more readily attract the major cotton pests. Effective insect control is necessary for Louisiana producers if maximum yields are to be obtained.

Mechanization, increased fertilization, and supplemental irrigation, associated with changes in cropping systems have intensified the problem of cotton insect control. Because of these inter-related factors, insect control is not necessarily a problem of entomology alone. Since the turn of this century the boll weevil (*Anthonomus grandis*) has been the major pest of cotton in Louisiana. In the last several years, however, the bollworm has become more of a problem and more damaging than the boll weevil. Resistance to insecticides has been shown by both of these pests.

Adequate control of ever-increasing insect populations requires a proportionately increasing number of insecticide applications. The process of genetic selection for resistance to insecticides is speeded up accordingly.

Insect control measures are developed around the requirements for controlling the boll weevil, and applications for control of other pests generally are combined with those of the weevil. Only eight years after the general use of chlorinated hydrocarbons the boll weevil has developed a resistance to them in some areas.

The first generation of boll weevils begins to appear soon after the first bloom. After a week of feeding, they begin to lay eggs. Three to four weeks after the first generation emerges, the second generation of weevils begin to emerge. Third and fourth generations follow in rapid succession. Mass migration occurs with increased population and decreased food supply. During years of heavy infestation, control is difficult, but a full crop can be produced by making regular insecticide applications. The initial application should be delayed as long as possible to protect species of predators and parasites and to retard development of resistance. Fields should be carefully checked at least once a week during the fruiting period. When 25 per cent of the squares have been punctured by boll weevils, insecticide application should begin.

Some cultural practices which have helped to reduce weevil infestation are the cultivation of larger fields and elimination of hibernation areas in and near the field. The most effective control, however, has been the use of insecticides. Calcium arsenate was used for control of the adult weevil for over 30 years. But since the second World War, a number of other effective insecticides have been developed. Insecticides presently recommended for weevil control in Louisiana are: Calcium arsenate, guthion, methyl parathion, sevin, strobane plus DDT, and toxaphene plus DDT.

Louisiana farmers have less effective methods for control of the bollworm and tobacco budworm than for the control of the boll weevil. In Louisiana the bollworms are more damaging than the tobacco budworm. The bollworms are also known as the tomato fruitworm or the corn earworm. A rather high level of resistance to DDT by the bollworms has been detected in all major cotton producing areas of Louisiana.

Bollworm eggs and small worms may be numerous in late June and early July. If no insecticide has been applied earlier, natural control is almost always effective. Damaging outbreaks of bollworms most often occur from late July into September. Insecticide applications should begin when eggs or small bollworms number 4 to 5 per 100 plants. Endrine, methyl parathion, sevin, strobane plus DDT, toxaphene plus DDT, and DDT are commonly recommended.

The pink bollworm is currently infesting the western portion of Louisiana. The control consists of a regulatory program of strict quarantine of the infested area, seed sterilization, burning of gin trash, and destruction of stalks.

Other insects that attack cotton in Louisiana and which should be controlled as outbreaks occur are cutworms, aphids, leafworms, thrips, and plant bugs.

Economical insecticides first used for insect control were calcium arsenate and Paris green. Prior to 1948 calcium arsenate was the primary insecticide used and this was utilized for the control of boll weevil. This material was very hazardous to use because it killed livestock grazing on the treated grass.

New synthetic insecticides were produced during or after World War II, including DDT, BHC, and chlorinated hydrocarbons. Most of the insecticides were first used as a dust. Sprays are more commonly used today to assure accurate application throughout the day. Mixtures of several insecticides are now used to control a number of pests. Regular insect control programs have been developed.

Applications of insecticides to cotton is made today by special high-clearance equipment or by plane. Weather exerts more influence on the damage by insects than any other factor, and this the farmer cannot control. The economics of good insect control are directly dependent upon using insecticides at the right time, at the rate needed, and on getting the correct distribution on the plant. Excessive use of insecticides should be avoided at all times.

Defoliants, Desiccants, and Harvesting

The use of harvest-aid chemicals in cotton production is extensive in most sections of Louisiana. Defoliation problems vary somewhat in different parts of the state because of climatic conditions, farming practices, and types of soil. Premature defoliation will reduce yields and lower quality. Defoliation has not proven economical in hand harvesting in Louisiana, but for mechanical harvesting under favorable conditions it is a desirable practice. Over two-thirds of the state crop is harvested mechanically and defoliant chemicals are used on much of this acreage.

Defoliation is a desirable practice when spindle machine harvesters are used and when a dense canopy of foliage is present. When leaves are succulent and moist, farmers should weigh carefully the economic advantages and disadvantages of the undertaking before attempting an extensive defoliation program. Good defoliation increases mechanical harvesting efficiency by reducing clogging of the spindles, sources of green stain on lint and dry leaf trash. After defoliation plants straighten up and in many cases this can result in a higher grade of cotton. Defoliation also makes possible earlier picking of cotton and in some cases a higher percentage of open bolls for the first picking. It permits dew to dry faster which allows picking earlier in the day. It retards fiber and seed deterioration. It helps in insect and disease control and earlier stalk destruction.

Defoliating too early increases immature fibers, cuts lint yield, and lowers seed quality. Applications too early or too late in the season, or use of too much material cause freezing or burning of the leaves and more leaf trash. It gives partial defoliation through poor coverage of defoliants and results in more leaf stain, higher seed cotton moisture, and more leaf trash.

Proper timing, therefore, is one of the keys to successful defoliation. The condition of the plant and the weather will determine proper timing. At least 60 per cent of the bolls should be open before defoliating. Those bolls to be harvested should be 30 to 40 days of age and not easily dented when pressed between the thumb and forefinger. Bolls at the top or ends of the limbs should not be easily sliced with a knife, and the fiber should string out. Warm temperatures give best results. Late afternoon or early morning with high humidity and no high wind is the best time for defoliation.

Adequate coverage and proper rate of application are essential. For plants 5 to 6 feet in height, and not densely overlapped, use 5 to 10 gallons total spray per acre when applied by airplane. Use 15 to 20 gallons of total spray per acre when applied by ground machine. Use 25 to 40 pounds of dust applied by air or ground equipment. A single flood-type nozzle should be used about 8 inches above the plant on ground machines. The spray should be directed downward and backward at a 45^{o} angle.

Nozzles that produce larger droplets give best results. Use one or two extra flood nozzles per row for extremely rank growth. They should be placed behind the shield in the middle of the row to spray on lower leaves. Two applications one week apart may be needed for rank cotton.

Bottom or partial defoliation can be successfully accomplished with some care on the part of the operator. Baker (4) found that under certain conditions this may be effective in reducing boll rot, but the value is exaggerated in many instances.

Dusts are not used extensively because of wind blowing and the need for dew or moisture to obtain best results. Calcium cyanamid and sodium chlorate type of dusts give the best results. Of the sprays, organic phosphates and chlorates have given the most efficient leaf drop. Leaf drop should start within four to eight days after defoliant is applied. Under favorable conditions defoliation should be completed in 8 to 10 days. However, if the maximum temperature is below 60° F., leaf drop is slowed and is incomplete.

Defoliation can be made more effective by careful attention to pre-harvest practices that promote uniform, well-fruited and evenly matured plants. Defoliation is affected by other conditions such as soil fertility, land uniformity, plant population, soil moisture, insect control, and weed control.

Wetting agents may be beneficial to defoliation in unfavorable circumstances, particularly where the organic phosphate chemicals are being used.

Desiccants may be used where plant and climate conditions are such that defoliants fail to do an adequate job. This is normally where second growth is a problem, or where vines and tall weeds are so thick they interfere with mechanical harvesting. The two chemicals which are commonly used as desiccants are arsenic acid and penta-chloraphenol. Desiccants are not extensively used in Louisiana.

Harvest-aid chemicals have been subjected to regulation under Public Law 518 since March 6, 1960. Directions should be followed at all times.

Harvesting is the most costly operation in cotton production. A farmer can increase his net income per acre considerably through proper harvest management. Improper harvesting, whether by machine or hand, can cause excessive damage by increasing moisture, trash, and other contaminants that are difficult to remove in the gin without damaging the quality of the fiber.

Harvest methods have changed during the last few years from primarily hand harvesting to predominantly mechanical harvesting. In 1950, 3 per cent of the cotton crop in Louisiana was harvested mechanically. By 1962, the figure had risen to 65 per cent. The Louisiana Department of Labor estimates that in 1963 about 80 per cent of the crop was picked by machines. There were 1,466 mechanical harvesters in use in Louisiana in 1962, and an estimated 1,588 in 1963.

The harvest season in Louisiana is now concentrated in a six- to eight-week period. Mechanical harvesting is not only more economical than hand harvesting, even after grade reductions are taken into consideration, but it also assures the producer of being able to harvest at the right time. The supply of hand labor is becoming smaller, less dependable, and less efficient each year.

There are several factors which may lower cotton quality when picked by machine. One is picker-twist, which usually results from improper doffing, too much or too little water on the spindles, improper picker speed, or incorrect drum setting. Other quality-lowering factors are: green leaf stain resulting from poor defoliation, regrowth, tight pressure plates, or excessive packing; excessive trash caused from poor defoliation, excessive pressure on the pressure plate, trash picked up from the ground, failure to clean out picker, and mixing of trashy harvested cotton with clean harvested cotton; grease and oil; and bark from stalks which is caused by driving off the row, too much pressure on the pressure plates, and excessive speeds. All of these conditions contribute to lowering of the quality of mechanically harvested cotton. These problems can be eliminated through proper management.

The moisture content of cotton should be 10 per cent or below for best results with mechanical harvesting. This level of moisture normally occurs in Louisiana between 8 and 10 a.m.

Field conditions affect mechanical harvesting greatly. Land should be level and uniform, with all pot-holes eliminated. Long rows that cut down on the number of rows and reduce the amount of turning necessary at the ends of the field save time in picking. Uniformity of stand and spacing is important. A plant population of 35,000 to 45,000 plants per acre will maintain more uniform pressure on the picker drum thereby increasing harvest efficiency. The variety will also affect efficient harvesting. Lodging, lack of storm resistance, and excessive branching reduce mechanical harvesting efficiency. High row profiles hamper mechanical picking, as do poor defoliation, weeds, insect damage, and disease.

In the Mississippi valley, over 90 per cent of the hand-harvested cotton is picked rather than snapped. Only in extremely wet falls when cotton is in the fields in December and January do cotton producers harvest by snapping. "Snapping" is harvesting of the entire open boll.

Hand harvesting may begin as soon as a few bolls are opened. Normally in the alluvial areas there are first and second pickings, followed by a scrapping. Since World War II, the efficiency of hand picking has been declining, but ginning facilities for cleaning, drying, and storing cotton have continually improved.

The two types of mechanical harvesters used are the stripper type which is not employed extensively in the alluvial areas, and the spindle type which is the one primarily used in Louisiana. There are currently four spindle type pickers: International Harvester, John Deere, Allis-Chalmers, and Rust.

Costs for mechanical harvesting range from 15 to 25 dollars per bale as compared to approximately 50 dollars per bale for hand harvesting. With mechanical harvesting there is a slight decrease in grade and a slight increase in field loss, but the mechanical method of harvesting is more economical.

Handling and Ginning

Proper handling is more important today than ever before. The quality of cotton cannot be improved from the time the cotton opens until it reaches the spinning mill, but it can be maintained.

In the early days, cotton houses were located throughout cotton fields. Hand pickers placed cotton in the houses until a bale of seed cotton was on hand. Then it was transported to the gin. Little was known about maintaining cotton quality. Grade and staple length were the two primary factors on which cotton was bought and sold.

Today, growers realize that seed cotton being hauled from the field to the gin is subject to a lot of damage. Cotton should be covered when being hauled to the gin. This precaution prevents blowing away and protects it against rain and contamination. Cotton should not be trampled in the trailer since this tangles trash in the fibers, which the gin cannot remove completely, and it tends to increase staining from green leaves which may be present.

Cotton should be grouped at the gin rather than handled on a first-come, first-serve basis. Wet trashy cotton should be placed in one group and clean dry cotton in another. This will avoid over-drying and over-cleaning of the clean cotton when the gin is set for the trashy wet bales.

High moisture content and green trash are the main causes of the loss of quality in stored cotton. Deterioration can be expected within one day of storage if moisture content of the seed cotton is 12 per cent or more. Producers should have enough trailers on hand to hold at least one day's harvest. Each trailer should have a capacity of at least three bales, 750 cubic feet, and should be of suitable height to accommodate basket dumping of the mechanical picker. A solid-front trailer should be used to reduce dust and dirt contamination in hauling.

The producer should inform the ginner of the condition of his cotton and cooperate in a plan of systematic gin-yard grouping of trailers according to the condition of the cotton.

The increase in percentage of mechanically picked cotton has not only shortened the ginning period from several months to about ten weeks, but it has brought on additional problems. Ginners have been forced to add cleaning equipment in order to remove foreign matter from seed cotton. The number of cotton gins in Louisiana has declined from over 1,000 at the turn of the century to about 210 in the last few years. The capacity of the modern high-speed gin is from 4 to 6 times greater than that of the older out-dated gins.

In order to handle machine picked cotton, the modern gin will have two tower driers, an overhead seed cotton cleaner with 12 to 15 cylinders, a green boll trap, a stick and burr machine, and at least two lint cleaners. All of this equipment is in addition to the regular gin. The investment in a modern plant with this type of equipment will range between 200,000 and 300,000 dollars. The key to obtaining a profit from such an investment is volume. It is possible for this modern type gin to obtain a volume of between 8,000 and 10,000 bales in a season, compared to 1,000 to 2,000 bales handled by older plants. The average cost to the producer of ginning in recent years has been 18 dollars per bale.

Quality, Marketing, and Utilization

For many years the two primary factors used to determine cotton quality were grade and staple length.

Color, leaf content, and preparation all determine the grade of cotton. Grade helps to indicate the amount of waste per bale in trash and unusable cotton. It determines the purpose for which the fiber can be used and indicates how much effort will be involved in getting the cotton ready to be spun into yarn. Grade is determined by comparing the samples with standards of the grades which have been agreed upon by experts in the cotton trade.

Staple length of the fiber is very important to the spinner. Long fiber is needed in making fine yarns. As a rule, longer fiber will also be stronger and finer. The lengths of American Upland cotton, stated

Baker (6), are usually classified as follows: short staple, less than 1 inch long; medium staple, 1 to 1-3/32 inches long; and long staple, 1-1/8 to 1-11/32 inches long.

In recent years, mills have begun evaluating cotton for what might be called spinning quality factors. Because of rising cost and competition from man-made fibers, cotton mills have increased the speed of operations and at the same time have attempted to improve the quality of the manufactured product. Mills have been compelled to evaluate cotton quality more accurately. This has led to the development of scientific instruments to measure accurately the spinability of the raw cotton fiber. The principal spinning quality factors are fiber strength, fineness, length uniformity, and maturity. All of these factors, and others, are referred to as character. Today, the commercial cotton buyer may evaluate cotton not only on grade and staple length but also on character. And character is made up of all other physical characteristics of cotton not included in grade and staple.

More and more emphasis is being placed on the fiber properties which make up character. Fiber fineness is influenced mainly by heredity or variety. It is affected also by growing conditions, such as availability of soil moisture and plant nutrients. Fineness is adversely affected by frost, diseases, and defoliants applied too early. It is not influenced by harvesting or ginning.

Several instruments are used to determine fineness. The most commonly used is the Micronaire. The Micronaire fineness values are as follows:

Index of Micrograms per inch of fiber

Below 3.0	Very fine
3.0 to 3.9	Fine
4.0 to 4.9	Average
5.0 to 5.9	Coarse
6.0 and above	Very coarse

Cotton which possesses extreme values of fineness is either discounted heavily or not purchased.

Data on fiber fineness tests are available on 86 per cent of the cotton purchased by mills from shippers. After cotton leaves the local market, the cotton trade buys on the basis of the Micronaire test for fiber fineness.

The Micronaire is also useful for obtaining a measure of cotton maturity. The machine gives only an indication of fiber maturity but this is acceptable to mills for making their cotton purchases. Fiber maturity is rarely measured directly, except in research, because of the cost and time involved. Most Louisiana cotton normally falls in the 4.0 to 4.9 fineness range. Mills suspect fiber immaturity in cottons when readings fall below 3.5.

The United States Department of Agriculture will include Micronaire as an additional quality factor for Upland cotton placed in the price support loan program beginning with the 1964 crop. Discounts will be made for Micronaire readings below 3.3 and above 5.1. A premium will be paid for Micronaire readings 3.7 through 4.8.

The second most popular fiber measurement is strength. The Pressley fiber tester is the most common instrument for commercially testing strength of cotton. Mills are especially interested in knowing fiber strength because it determines the strength of the yarn processed from the cotton and influences efficiency in manufacturing. Strong cotton means strong yarn and fewer manufacturing troubles.

Fiber strength is determined primarily by heredity, but it is also affected by available plant nutrients and moisture. Diseases such as fusarium wilt and boll rot will reduce fiber strength. Fiber strength can also be reduced by extreme over-drying at the gin.

The following ratings are generally accepted in interpreting 0 gauge fiber strength results in thousand pounds per square inch:

Above 95	Very strong
86 - 95	Strong
76 - 85	Average
66 - 75	Fair
Below 66	Weak

Baker (9) predicted that as interest increases in the improvement of cotton fiber measurements, the testing of fiber fineness and tensile strength and other tests will become an even more important factor in selling and buying cotton in mill operations. If farmers are to produce the kind of cotton mills need, they must know fiber qualities.

Great strides in improvement of production practices have been made during the last three decades. But marketing practices have changed little at the farmer's level. The growers have concerned themselves primarily with production and with obtaining maximum yields. The day of the small local cotton buyer has gradually passed, and most cotton is now marketed through large cooperatives, such as the Staple Cotton Cooperative Association in Greenwood, Mississippi, or through the government loan program.

Before selling their cotton, farmers should accurately determine its worth. The cotton should be classed by the Government Classing Service, then, if the marketing price is too low at harvest time and the producer needs the money, he may place the cotton in the Commodity Credit Corporation Loan Program.

The producer must keep uppermost in his mind the fact that cotton and cottonseed utilization is necessary if he is to continue cotton production. After years of heavy marketing through the Commodity Credit Corporation Loan Program, many cotton farmers have begun to think of growing cotton for the loan rather than for the market.

By special treatments cotton has been given wrinkle resistance, rot and mildew resistance, flame resistance, and glow-proofing. One of the newest developments is the all-cotton stretch fabrics. The addition of these new properties has broadened the market for cotton.

Cotton utilization research covers a wide range and includes thousands of items. The key to future cotton utilization is competitive pricing and development of new processes which extend the use of the cotton fiber.

The Role of Cotton In The Future

The writer does not share the pessimistic outlook held by so many concerning the future of the cotton industry in Louisiana. The cotton industry truly faces many problems, some of which seem almost insurmountable, but cotton has survived through more than seven thousand years of human history. No other fiber has ever duplicated cotton's combination of desirable properties. This important industry will make the necessary adjustments for survival.

Legislation greatly influences cotton production and cotton production practices, including acreage and cultivation methods. Producers are becoming more conscious of the need for cotton to remain competitive in order to maintain its market. The 1964 cotton legislation reflected this consciousness and will tend to move cotton prices to a more competitive position. Fibers are competitive on the basis of quality, promotion, and price.

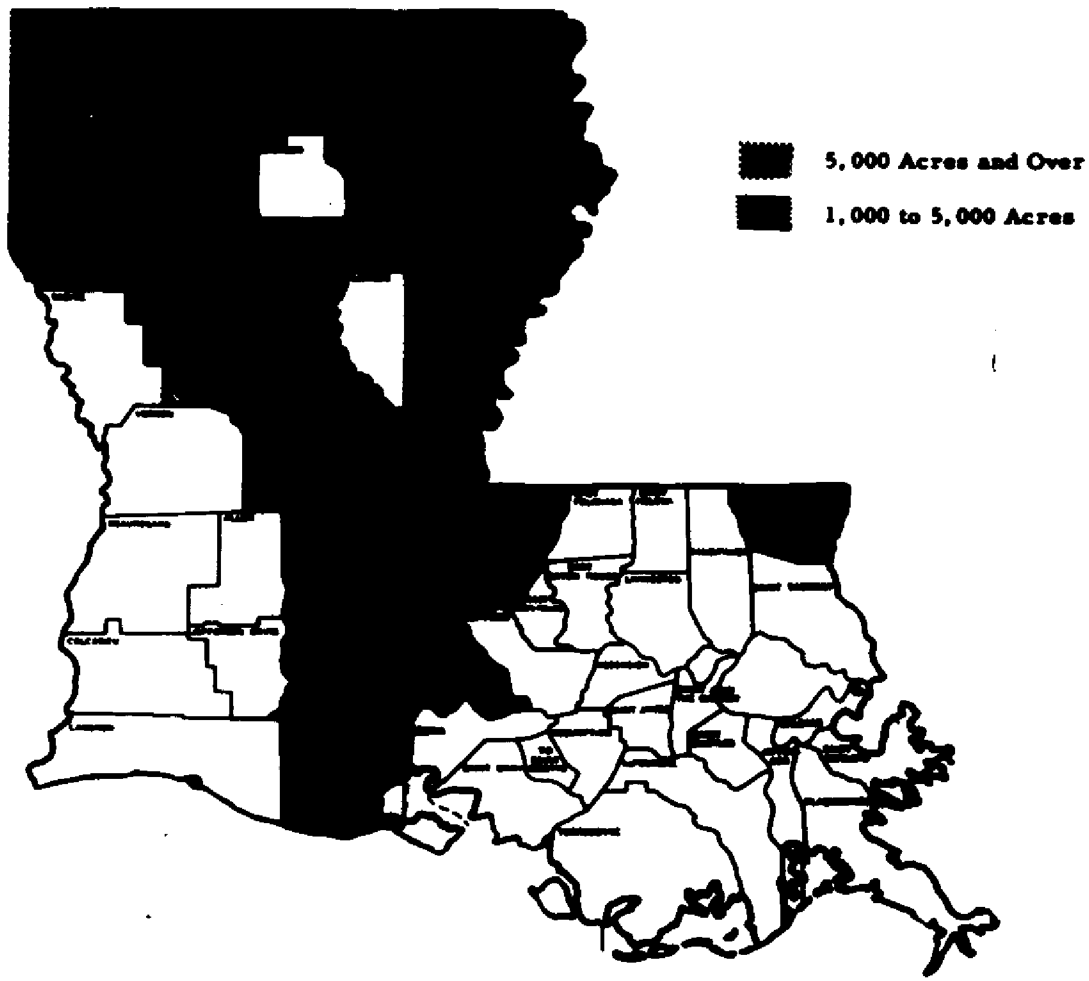
Cotton production in the future will continue to be concentrated more and more in the alluvial areas as has happened during the last two decades, which is indicated in Figure 2. Farms will continue to become larger. Fields will be larger, with longer rows, with better drainage, and with a smooth surface. In areas where farms cannot be enlarged, producers will rent additional acreage in the community in order to increase their volume. This will be necessary in order to justify, for example, buying of two-row mechanical pickers, which cost approximately 20,000 dollars, and other costly equipment. More push-button farming equipment will come. In the developmental stage of research is such equipment as self-guided tractors which are kept on course automatically by sensitive feelers that brush along the edges of the rows, and farm equipment that can be operated by electronically taped instructions, beamed to the vehicles by radio signals. These are some of the far-off equipment changes which will come about on the Louisiana cotton farm.

As investment in equipment increases, invariably the need for proper maintenance and care increases proportionately.

This writer does not believe that farm equipment will increase much in size. Four- to 8-row equipment will probably be the maximum.

More varieties with specific characters, such as wilt-resistance or earliness, will be planted in Louisiana. Louisiana will be less of

Figure 2. Map Showing the Distribution of Cotton Acreage in Louisiana.



a one-variety state in future years than in the past three decades. The next big breakthrough in varieties may be the production of a true hybrid.

Weather, next to legislation, probably influences cotton production more than any other factor. Louisiana cotton farmers can control effectively such variables as diseases, insects, and weeds. However, weather remains the largest variable without control. In the future, cotton farmers will study weather forecasts, which will become more accurate and dependable, and will farm on the basis of long-term weather records. Supplemental irrigation will become more prevalent, to offset weather variables in cotton production.

Soil preparation, seeding, fertility and cultivation methods will be simplified. With the depletion of soil organic matter and increased use of chemicals, more rotation will be necessary.

As weed control becomes more efficient, the rows will become narrower. Fertilizers, fungicides, insecticides, and herbicides will all eventually be applied in fewer operations. Weed control will become more efficient with a larger array of chemicals from which to select. Chemicals applied at planting time will tend to remain effective throughout the growing season. Fewer mechanical cultivations will be required.

Disease control will be improved through breeding and use of chemicals. In the future there will be more use of chemicals not only for the control of seedling disease and nematodes, but also for the control of boll rot. Chemical applications for the control of boll rot will be made during the same operation as the last insecticide application.

Control of cotton insects will become more efficient with new approaches. More efficient systemics will be developed in the near future. Resistant cotton varieties offer a tremendous potential. Other areas that will probably develop over a period of time are the sterile male technique, infectious diseases of insects, attractants and repellents, and integrated biological chemical control. Large strides will be made in the future through these new approaches to insect control.

The defoliants presently available still perform to varying degrees under different conditions. More dependable chemical defoliants will be forthcoming in the next few years.

Ninety per cent of the crop will be harvested mechanically in the very near future. The mechanical harvester will not become larger than the two-row models presently available. Four-row models already have been tested and are unsatisfactory under moist soil conditions.

The number of gins in Louisiana will continue to decrease, but the gin capacity will increase. The ginning season will become even shorter and this, in turn, will bring on increased problems of handling and storage of seed cotton.

Techniques and instruments for more accurate quality evaluation will be developed and will be used extensively down to the farmer level.

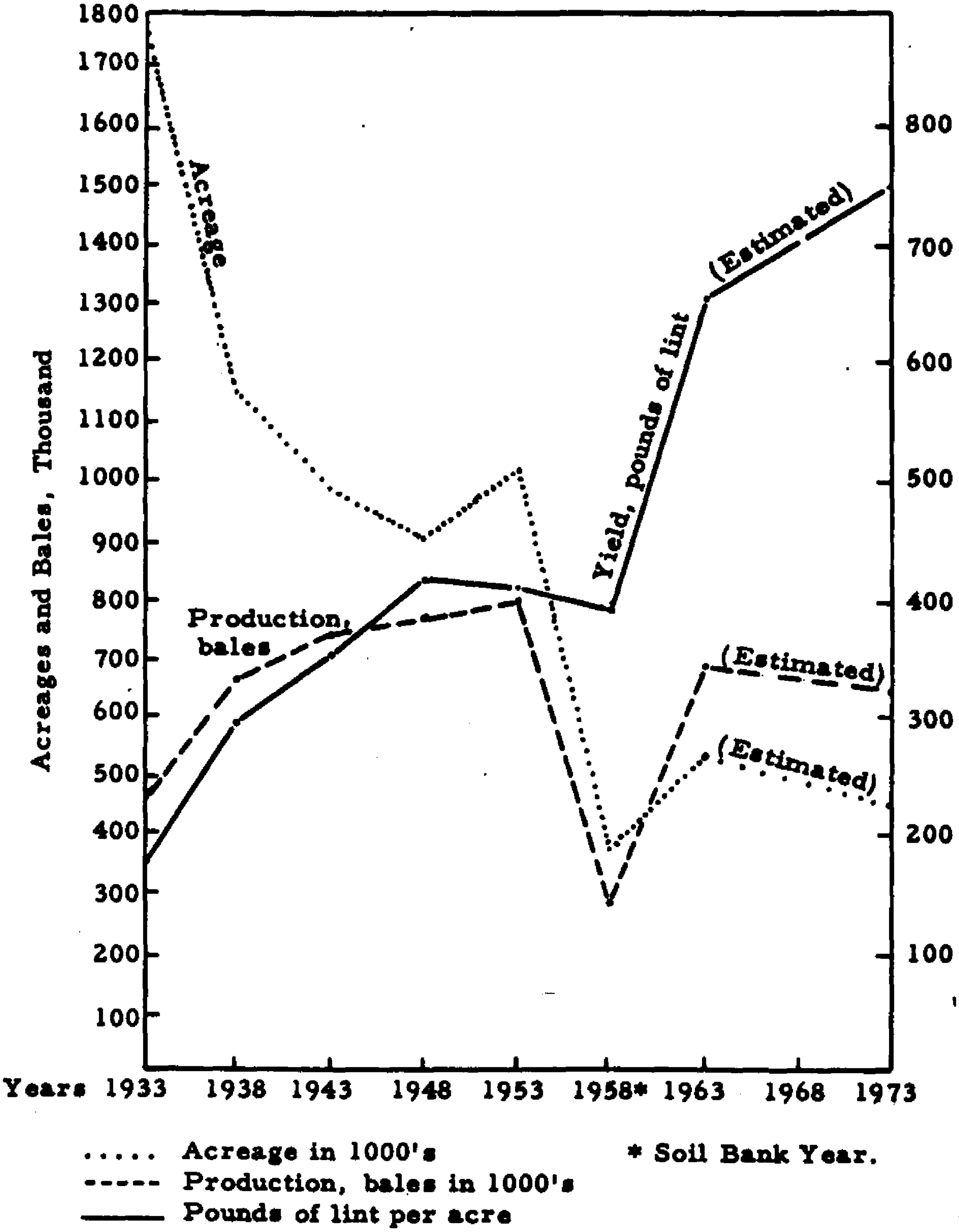
Improvement in marketing methods offer one of the greatest potentials for the expansion of cotton production. Producers will take a greater interest in efficient marketing and in selection of sales outlets. They will become more conscious, from the utilization standpoint, of quality, promotion, and price. They will increase their cooperative contributions to the promotion of the use of cotton.

Man-hours required to grow an acre of cotton will be reduced from 25 and 75 to 10 and 25 in the very near future.

Associated with the changes described above, management will prove to be a key factor. One practice tends to influence another. Management will be required to consider all improved practices as a whole. Greatly increased yields and cost reductions can be achieved by those growers concentrating on a total program for efficient production.

It is this writer's opinion that cotton acreage in Louisiana during the next decade will tend downward, as indicated in Figure 3. Yield will continue upward, approaching a state average of approximately

Figure 3. Cotton Acreage, Bales Produced And Yield Per Acre for Louisiana From 1933-1963.



Source: Louisiana Crop Reporting Service.

750 pounds of lint per acre. Total number of bales will remain at about the same level.

SUMMARY

A study has been made to examine analytically (a) varieties and changes in varieties; (b) climatic and moisture requirements; (c) soil preparation, seeding, fertilization, and cultivation; (d) weed control; (e) disease control; (f) insect control; (g) defoliants, desiccants, and harvesting; (h) handling and ginning; (i) quality, marketing, and utilization, and (j) the role of cotton in the future.

Information was obtained by review of literature on cotton , by participation on the Louisiana Agricultural Extension Task Force Study Committee On Cotton Production Practices, and by personal observations as Extension Cotton Specialist.

Cotton has been cultivated by man for more than seven thousand years. Efforts to change the plant and its fiber have been made throughout that period. Today's cotton burs appear very similar to those found in Mexico, which have been dated at about 5800 B.C.

There is no one variety which is best for Louisiana growers. A producer should select varieties from the recommended group for his area, then plant seed which have been delinted and treated with a fungicide. The seed should have a germination of above 80 per cent and should not be more than two years from breeder's stock.

Climatic conditions greatly affect cotton production in Louisiana,

and considerably influence production practices. Producers could make more extensive use of available weather information and long-range forecasts in planning their work.

The seedbed should be well pulverized but firm. It should be smooth and uniform in height. Clay soils should be broken in the fall or winter. Light textured soils may be broken in the spring except in areas where deep breaking is necessary in the fall to remove hard-pans or where large amounts of crop residue must be turned under.

The increasing use of heavy equipment and continuous cropping are tending to reduce the efficiency from fertilizers. It will be necessary in the future to give more attention to the condition of the soil. Organic matter content, soil tilth, and compaction must be considered.

The amount of fertilizer needed can be determined by soil tests and field observations. Sixty to 120 pounds of nitrogen per acre is commonly applied. The amount of P_2O_5, K_2O, and lime should be determined from soil tests.

Planting should be done after the soil temperature averages 65° F. at a 2-inch depth for three consecutive days. It is preferable to hill-drop or plant to a stand. A plant population of 35,000 to 45,000 plants per acre is most desirable.

Cultivation is primarily for weed control and should be done only when necessary. Weed control techniques have changed in recent years. Methods available to the farmer include chemical weed control, crop rotation, hand hoeing, mechanical cultivation, grazing by geese, and flame cultivation. New chemicals for weed control in cotton show great promise.

Relatively large losses from diseases such as boll rot, seedling disease, and fusarium wilt occur in Louisiana. These losses reduce yields by as much as 14 per cent. Fungicides, cultural practices, and resistant varieties help overcome these losses.

An insect control program must be adequate and economical. Timing, rate, and efficient application are the keys to good control.

Defoliation before mechanical harvesting normally is necessary in Louisiana. Defoliants should not be applied until 60 per cent of the cotton bolls are open.

Mechanical harvesting provides the greatest opportunity to cut man-hours per acre required to produce cotton and at the same time cut the cost of production.

Great changes in ginning and handling have been brought about by mechanization and changes in cultural practices. Teamwork between the farmer and the ginner can result in maximum ginning efficiency.

Cotton quality must be maintained if cotton is to be utilized by spinning mills. More accurate measurements for determining the quality of cotton are being developed and used.

Farmers will grow cotton to supply the demands of the consumers, but the efficiency of those involved in cotton production will determine who will grow the crop.

It was found that the development or changes in each of the factors studied greatly affected the others. For example, defoliation was affected by fertilization, weed control, insect control, disease control, and varieties. Because one practice greatly affects the other, the grower must approach cotton production from an overall point of view. Efficiency in all practices must be obtained if maximum profits are to be realized.

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AU TOBIOGRAPHY

AUTOBIOGRAPHY

Billy Jack Baker was born at Calhoun, Louisiana on August 12, 1929. He received his elementary and high school education in the public schools at Coushatta, Louisiana. From 1946 to 1948 he attended Northwestern State College at Natchitoches, Louisiana. In 1948 he transferred to Louisiana State University where he received his Bachelor of Science degree in Vocational Agricultural Education in 1950. After completing the summer semester of 1950 at Texas A. & M. College, he enrolled in Graduate School at Louisiana State University. In 1951 he enlisted in the U. S. Army and served until 1954. He re-entered graduate school at Louisiana State University and received his Master of Science degree in 1954. After graduation he was employed by the Louisiana Agricultural Extension Service as Assistant County Agent and assigned to Vernon Parish. In 1955 he was transferred to Caddo Parish, working as Assistant County Agent until May of 1958. At that time he was promoted to the State Office as Assistant Agronomist, serving as cotton specialist until 1963.

In March 1963 the writer accepted employment with Elanco Products Company, a Division of Eli Lilly and Company, as area representative. In March 1964 he was promoted to Research and Technical Coordinator (Southeast) serving as administrator of the southeastern area of the United States.

On December 15, 1956, he married the former Norma Jene Hill of Shreveport, Louisiana. They have one son, Lane Cameron, and one daughter, Lynlee Caron.

The writer is now a candidate for the degree of Doctor of Philosophy.

EXAMINATION AND THESIS REPORT

Candidate: Billy Jack Baker

Major Field: Agronomy

Title of Thesis: Factors Affecting Cotton Production in Louisiana.

Approved:

M. B. Sturgis
Major Professor and Chairman

Max Goodrich
Dean of the Graduate School

EXAMINING COMMITTEE:

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Date of Examination:

May 13, 1964